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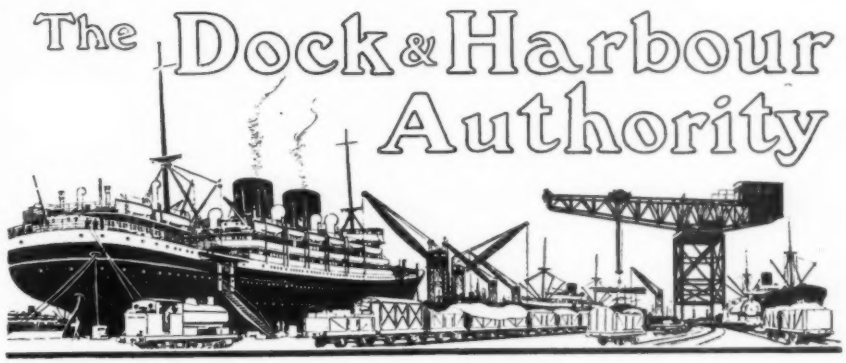

CONTENTS

953

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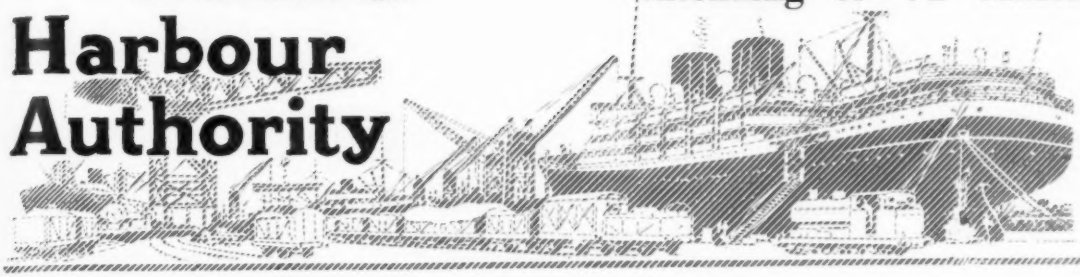

No. 389

Vol. XXXIII.

MARCH, 1953

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Editorial Comments

The Port of Boston, U.S.A.

It is almost exactly three and a quarter centuries since the city and port of Boston officially came into existence; the settlement had, in its early days, been called Trimountaine after the triple mountain peaks which could be seen across the Charles River. In the records of the company which came over from England with King Charles I's charter to form a government in Massachusetts, there is an entry dated September 17th, 1630, changing the name of Trimountaine to Boston—by which designation the city and port have been known ever since.

After a lapse of over 300 years, we need have no compunction in referring to that fateful day in December 1773 when the citizens of Boston threw cargoes of tea into the waters of the harbour in protest against the imposition of Customs duties, in the levying of which they did not have any voice or representation in the British parliament. While there were undoubtedly errors of judgment on both sides, it was this manifestation of active resistance to Britain's colonial policy in America that led to the Declaration of Independence by the thirteen colonies, and to Great Britain's final acknowledgment, in 1783, of the independence of the United States of America. Thus the city and port of Boston holds a unique position in the history of both countries.

Boston has always been a busy maritime trading centre, and today it is one of the most important cities, and also one of the most prominent ports in the United States. Until the formation, in 1945, of the Port of Boston Authority, the port was in a position rather similar to that faced by London about 1900, when a Royal Commission found the docks and port facilities in need of rebuilding and general unification; a state of affairs which has been rectified with excellent results by the inauguration of the Port of London Authority.

Readers will observe from a study of the article on a following page that, in the comparatively short period of time which has elapsed since the formation of the Boston Port Authority, considerable progress has been made in modernisation. A Master Plan has been prepared, and projects for grain-handling facilities, piers, marginal wharves and transit sheds, road, railways, and passenger terminals are nearing completion, whilst other extensive projects are in hand.

Boston has for many years primarily handled imports, and, in the past, has always been rather handicapped in handling export cargoes because of the comparatively light nature of the locally-manufactured goods which pass outwards through the port. With the possible exception of grain, none of the heavy bulk commodities such as oil, grain, steel, coal and coke, which form the major exports of many of the other Atlantic ports, can be expected to move in quantity through Boston. Consequently, the Port Authority has concentrated primarily upon modernising the grain-handling facilities of the port and placing them on a thoroughly competitive basis. It must be pointed out, however, that Boston has a very considerable local and coastal traffic, which largely balances the paucity of the foreign export trade, and it is satisfactory to note that since 1945 there has been a steady increase of trade in the port.

In a following issue we hope to print a further article which will deal with the engineering design studies undertaken in connection with the construction of No. 1 Pier, East Boston.

East Coast Floods Enquiry.

In view of our Editorial Comment on sea defence and floods last month, it is of particular interest to learn that Viscount Waverley, Chairman of the Port of London Authority, has accepted the British Government's invitation to become chairman of a committee of enquiry into the recent East Coast floods, and that the names of the other members will be announced very shortly. The committee will examine the causes of the floods and the possibility of their recurrence and consider what margin of safety in sea defences will be reasonable and practicable, having regard to the ratio between the estimated risks and the costs of such sea defences. They will also consider whether any further measures should be taken, by warning systems or otherwise, to lessen the risk of loss of life and damage to property, and will review the lessons to be learned from the disaster, and the administrative and financial responsibilites of the various bodies concerned, in providing and maintaining sea defences and replacing them in the event of damage.

In the course of his speech in the House of Lords upon the Government's action, the Joint Parliamentary Secretary to the Ministry of Agriculture, stated that approximately 95 per cent. of the breaches had been closed and that the inundated area had been reduced from between 150,000 and 175,000 acres to about 12,000 acres. Outlining the emergency measures which are being instituted by the Government, he said that sea defences along 1,000 miles of coast now have to be restored and strengthened. Work which would normally be spread over ten or fifteen years, now has to be planned and executed in six or seven months. This is an immense task, but he stated that the Government is determined that nothing shall stand in the way of its achievement.

The responsible River Boards have been advised that the Government will bear the entire cost of all sea defence works which can be executed before the end of September, to provide, as far as possible, the same standard of protection that existed before the disastrous floods of January 31st. Normally the maximum rate of grant payable by the Government is 80 per cent. In most cases the time available will not allow more than the restoration of the original standard of protection, and the problems inherent in providing stronger defences are under consideration.

Where industries, farmhouses and dwellings are affected it is obvious that no unnecessary risks must be taken and the provision of greater protection in these cases has been given first priority.

The financing of works outstanding at the end of September will be the subject of later consideration, but the immediate task will be to restore the sea defences as much as possible before the autumn. It is estimated that the cost of these restorations will be between £8 million and £10 million. The Ministry of Agriculture and the River Boards are co-operating fully on the urgent work of drawing up plans for permanent sea defences and putting them into operation. An interdepartmental committee has also been appointed to see that all questions are solved promptly.

A bill will shortly be introduced to give the River Boards special emergency powers, until the end of this year, to acquire land for erecting sea defences and flood embankments, and where necessary, for securing clay and other materials with which to build them.

Warm tribute was paid in the House to the River Board Engineers who had planned and directed the emergency repair works,

Editorial Comments—continued

to the prompt and effective action of Government Departments in coping with the emergency, and to the sympathetic handling of the situation by the Home Secretary, Sir David Maxwell Fyfe.

The proceedings of the committee of enquiry will naturally be lengthy in respect of future administrative and financial responsibility for sea defence works around the coasts of Great Britain. It is also clear that any comprehensive and costly increase in the standards of protection will be premature until a fundamentally sound knowledge is available of the tidal, atmospheric and other natural phenomena which may, on occasion, cause storm surges and abnormally high levels of water.

Government Statement on Netherlands Flood Damage.

A similar statement in the Dutch Chamber on February 9th announced that dyke repairs and investigations into the ways and means of preventing the recurrence of the devasting floods which swept the Netherlands were to be given immediate priority. Improvement of safety organisation and the submission of emergency legislation to cover additional expenditure on dyke repairs is under consideration; if necessary, reclamation work on the Zuiderzee will be slowed down to enable more urgent repair work in Zeeland to be completed.

The Government's spokesman stated that at the present time it is impossible to estimate the total cost of dyke repairs, but it is recognised that this cost will be far beyond the available local finances. The Government has therefore undertaken to pay for all necessary repairs, and to cover the bill for damaged property not covered by insurance under regulations in the spirit of the existing war damage act.

The position of the dykes was now almost stabilised and the majority of the breaches were limited in extent and could be repaired without undue difficulty. The dyke breaches on the islands involved in the disaster would be more difficult to repair, particularly in view of the problem of reaching these sites by road. The provision of drinking water and the disposal of animal carcases was the main problem in connection with public health and Walcheren was a danger point since not only had the whole population remained there, but the pumping station had been flooded.

A statement by Mr. J. Algera, the Minister for Transport and Waterways, said that unprecedented and exceptional masses of water flung at the Dutch coast for more than 24 hours had been responsible for the catastrophe. High tide had coincided with the climax of the storm and the water piling in from the sea had assumed the proportions of a tidal wave previously unknown in the history of the Netherlands.

Proposals from several quarters that the various sea arms around the coast of the Netherlands should be closed off were premature since this would be an undertaking much more difficult than the establishment of the great enclosing dam at the former Zuiderzee. A project of this nature would take decades to execute and no decision could be taken until the results of years of careful study had been examined.

The Discharge of Bulk Sugar.

The carriage of sugar in bulk across the sea from raw factory to refinery has been found satisfactory. It has, nevertheless, produced a number of handling problems, some of which are of unusual interest. In an article on page of this issue, the problems connected particularly with discharge from ship are discussed. They are problems not only for the discharging agent; they also vitally concern other interests, including Dock and Harbour Authorities and shipping companies. None the less, they necessarily revolve round the discharging agent, for he must ultimately meet the needs of the shipping company and also be bound by any conditions which the sugar refiner finds it necessary to impose.

Trimming, which must be done at loading as well as at discharge, is presenting the most interesting problems. Sugar does not flow like grain and similar commodities. Unfortunately, under certain conditions (some, at first sight, innocuous), it cakes. Caked sugar presents special difficulties and causes such concern as to bring the research chemist actively into the question of ship discharge.

Although the quantity of raw sugar in bulk brought annually to this country is large, the traffic is still in its infancy. Most machines so far used for trimming sugar are interim expedients, having been originally constructed for other work. Moreover, all machines which are capable of handling raw sugar are not necessarily suitable.

For the reasons mentioned, therefore, few permanent decisions have yet been made. Many of the problems are intriguing—particularly those concerned with trimming—and machine manufacturers, as well as sugar refiners and discharging agents, are actively engaged in attempts to solve them.

The Railways and Ports of Southern Africa.

Prior to the inauguration of the Union of South Africa, there was strong competition between the ports of Cape Colony and Natal, and continual friction and disagreement between the railways, which at that time, were owned separately by each of the four colonies. When union was achieved, the railways and harbours were combined and the revenues brought under one control: also at a very early stage the administration realised the potentialities of a new form of transport—the motor lorry or truck.

The formation of the South African Ministry of Transport seems to have been the consummation of a policy, consistently pursued since the date of Union, of co-ordinating all forms of public transport, and at that time the control and organisation of the railways, harbours and other transport services under one administration was unique in the world of transport, for they were the first to have been completely nationalised.

The success of the undertaking was marked by outstanding results, but the Second World War imposed a serious strain upon transport facilities. In view of the increasing development of South Africa, and the greatly increased post-war traffic, the railways and docks are undoubtedly accomplishing a herculean task to the point of overstraining their resources.

There is to-day in South Africa a considerable body of opinion which advocates the expenditure of greater sums of money upon the development and expansion of harbours, which it is alleged are in a subordinate position compared with the railways, whose interests, because of their magnitude, tend to be regarded as paramount. The interests concerned with the port industry go further, and suggest that the time is ripe for the decentralisation of the transport administration with a separate port authority for each port, but under the control of a South African Harbour Board, upon which each port would be represented.

Judging from the benefits gained in other countries, where some such systems of port control are in being, there seems to be some justification for cognisance to be taken of the authoritative opinions expressed. Readers will find much worthy of note in the article which will be found on a following page and the outcome of the various suggestions in respect of additional rail links and port development will be followed with considerable interest.

Port of Piraeus Improvements.

One of the first problems examined by the new Greek Government formed by Marshall Papagos, was the completion of the work of reorganising the Port of Piraeus. Among matters still to be settled are reduction in labour costs, the completion of the reconstruction of the remaining section of the port, the re-habilitation of the finances of the Piraeus Harbour Organisation, and the reorganisation of its services.

The Government has decided to remove the large floating dry dock, acquired from German reparations, from the Port of Piraeus to Syra. This dock, which has a capacity for vessels up to 12,000 tons, is now anchored in front of a large quay, thus preventing ships from coming alongside and discharging in that part of the harbour. The establishment of the dock in Syra will give added impetus to the shipbuilding industry of the island, which is now dwindling; it will also free the quay at the Port of Piraeus which cannot at present be used, so that it will become available for the discharge of coal by means of the crane bridge which is now ready to operate.

In the article describing the Port of Piraeus which appeared in the December, 1952, issue of this Journal, by an unfortunate typist's error in the original MS., the length of quay walls reconstructed by the Technical Services of the port was given in the first column on page 228 as 2,250 metres, whereas the actual length should read 250 linear metres.

The Port of Boston, U.S.A.

Details of Extensive Modernisation Plans

By GEORGE L. WEY, Chief Engineer, Port of Boston Authority.

INTRODUCTION

BOSTON, in the State of Massachusetts, in the north-eastern part of the United States, is known throughout the world for its soul-stirring part in the history of the nation. It is famed for its clipper ships, fishing industry, educational institutions, even its baked beans, and, last but not least, its port, which has played such a strong role in world commerce from the days of the country's first settlement.

Historically speaking, the Port of Boston was the first major port in the United States, and had its beginning early in the seventeenth century, shortly after the arrival of the Puritans. It was only logical that the city became a centre of waterborne commerce. Its storm-sheltered harbour and deep waterways, with very little current, practically free of estuary sedimentary deposits; its closeness to the open ocean; and its excellent hinterland accessibility — all contributed to the development of the port. Boston Harbour comprises a tidewater area of about 47 square miles, with a shore line of more than 100 miles. The maximum current velocity is less than one knot. It is only seven miles from the open ocean to the centre of the waterfront terminal area.

Originally all the commerce of Massachusetts Bay was with England. In 1641, when the Civil War there disrupted normal trade, Boston quickly sought other markets, and thus began its foreign trade, with salt fish as its principal export product. This port was the principal point of entry when the vast immigration commenced, with the arrival of 1,500 colonists in 1630. During the days of the clipper ships, the finest vessels were built in Boston's yards, and carried the name and trade of the city to every corner of the globe. Then came the days of steam transportation, and, with the arrival of the *Britannia* in 1840, the establishment of regular passenger service by the Cunard Line between Great Britain and the United States. The Port of Boston prospered, and has continued to this day to maintain its strong place in world maritime trade. Boston had the first Naval shipyard in the country, where some of our early warships were constructed.

In the history of the port, there has always been a strong influence of progressiveness, which has numerous times set the pace for the rest of the nation to follow. For example, early in the 20th Century, the State of Massachusetts constructed in Boston what was then one of the largest drydocks in the world; it is still in excellent condition and is in use by the Navy. The Commonwealth Pier No. 5, built in 1912, was an ultra-modern pier far in advance of its day, for both general cargo and the handling of passengers. It was the forerunner of our present-day modern-design waterfront terminal, and is still considered to be one of the finest piers in the United States. At about this time also, the Boston Fish Pier was constructed by the State for the fishing industry, which had previously used the picturesque but inadequate small piers along the old Atlantic Avenue section of the waterfront. Boston's fishing industry set the pattern for the world in the efficient processing of fish on a large scale.

After this spurt of progressive accomplishment to take care of foreseeable future needs, future development was planned just prior to the entrance of the United States into World War II. Plans and funds were authorised for the construction of a new pier in the Mystic area of the Charlestown section of the city, but construction had to be postponed until after the termination of the emergency. During World War II, the waterborne commerce of the Port of Boston was entirely military. In 1944, it became apparent that when the war ended, it would be necessary to revise any existing plans for the accommodation and development of post-war maritime trade because of the change in the size and capacity of vessels, the greater use of mechanical equipment for cargo handling, the anticipated larger volume of trade, and the inroads made by highway vehicular transportation on rail traffic serving the port.

In order to facilitate and accelerate the handling of the many vital port administrative and development programmes, the Port of Boston Authority was created in 1945 by an Act of the Legislature of the Commonwealth of Massachusetts, with the power to embark on a master plan for providing the port with adequate modern terminal facilities to handle anticipated expanded commerce requirements. For this purpose, an initial outlay of $19,700,000 was approved by the Legislature.

MASTER PLAN

In the preparation of a Master Plan for the development of new port terminal facilities to acccommodate present demands of waterborne commerce and to provide sufficient margin for future expansion, the following were the basic considerations:—

(1) Best utilisation of waterfront area and improved waterways;
(2) Accessibility by rail and main highway arteries;
(3) Closeness to source of waterfront labour;
(4) Least possible disruption of normal activities of area;
(5) Maximum economy of design and construction.

On these criteria many studies were made of the best plan for attaining our development objective. They resulted in the following formula for the Master Plan:—

"Certain obsolete piers were found to be strategically located for maximum efficiency in the interchange of waterborne cargo by rail and highway transportation, satisfying the requirements of good supporting facilities, and could be reconstructed upon modern standards, not only increasing the efficiency of the cargo-handling process, but also at the least cost and providing the necessary margin of capacity for future expansion."

Terminals constructed on new sites hitherto unused for such purpose were found to be more costly, and did not satisfactorily meet all the basic requirements of a modern terminal.

The initial master plan prepared in 1947 consisted of four projects, each taking maximum advantage of railroad and highway facilities, availability of labour, and ease of navigational approach. The four projects are: Hoosac Pier No. 1, which was completed in 1950; Mystic Pier No. 1, completed in 1952; East Boston Pier No. 1, on which construction is about to commence; and the first-stage development of the Castle Island Terminal, which is to begin in 1953. These four projects will be discussed later in this article. The materialisation of this plan does not favour one particular section of the city; the projects are distributed evenly along the waterfront so that every part of the port is benefited.

Fig. 1 is a plan of Boston Harbour showing the location of proposed terminals in the Master Plan.

Our plans for the various projects are co-ordinated in a long-range plan so that future development may not be prejudiced because of lack of vision, and may be accomplished with as little as possible disruption or displacement of waterfront business and establishments.

Because of existing commerce demands, it was not possible to proceed with the construction of more than one project at a time without jeopardising the normal flow of business in the port. One pier at a time has been scheduled for construction, with the displaced business of that pier being absorbed by other terminals in the port. Each new pier being constructed will provide that necessary margin to handle the business of the pier being replaced while reconstruction is going on, as well as to take care of such new business as may be acquired after completion of each step in the overall developments.

Every year the needs of our waterfront commerce are re-studied, and changes made to reflect current forecasts.

In 1950, two additional projects were added to the Master Plan, the modernisation of East Boston Pier No. 3, and the Northern Avenue Oceanic Terminal, the completion of which is expected to maintain our competitive position until 1960.

In the actual planning of these piers, stress is placed on the economic aspect of func-

Port of Boston, U.S.A.—continued

tional layout with design and construction to be consistent with maximum efficiency of operation and low maintenance. Since the enabling legislation requires 20-year leases with amortisation of the construction costs at the rate of 3% per year, every bit of Yankee thriftiness and ingenuity has to be used to keep the cost as low as possible. There is nothing ornamental or monumental in the pier design. It is all purely functional, with only such architectural treatment as may be given without increasing the cost. The appearance of our transit sheds is attractive, a result which has been attained by skilful use of simple lines, and the careful arrangement and use of low cost materials

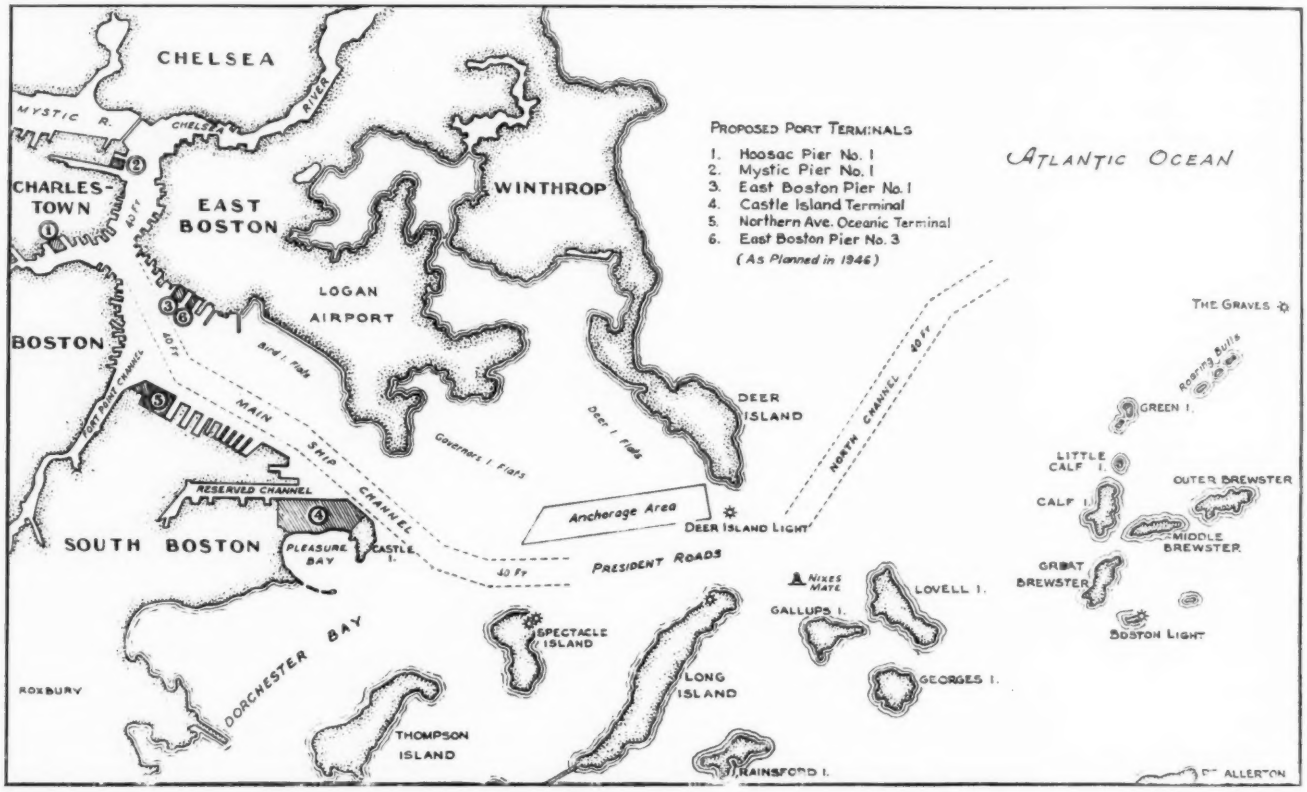


Fig. 1. Plan of Boston Harbour showing location of proposed port terminals in the "Master Plan."

DESIGN CONSIDERATIONS

In layout, all the new terminals follow the basic pattern of a finger pier with one-storey transit sheds, except for the Castle Island Terminal, which is a marginal wharf about 4000-ft. long. The piers have working aprons 25-ft. wide, with flush railroad tracks, ship water supply connections for each berth, and adequate illumination with non-glare lights for night work and security. The terminals have one-storey transit sheds of fire-resistant materials, with a 20-ft. overhead clearance for maximum stacking of cargo; railroad tracks in a depressed well in the centre of the shed for flush loading of railroad cars; truck docks for platform-height loading of trucks; ramps for the entrance of trucks into the sheds; good natural lighting for daylight operation and excellent artificial lighting for night work; the best type of sprinkler system for fire protection, with an automatic and manual fire alarm system; power-operated trackwell bridges for flexible movement of cargo from one side of the shed to the other; warm rooms for perishable cargo; and offices for steamship and terminal-operating interests.

An added adjunct which is entirely new in American ports is the utility building adjacent to the pier, housing a forming or shaping hall for longshoremen, and the repair shops for cargo-handling equipment removed a safe distance from the transit shed. The plans provide for adequate open storage and parking areas, with good flood lighting. The entire terminals are enclosed with an 8-ft. high chain-link type of fence to provide maximum security at the least cost. These new piers each have large railroad classification yards adjacent to the piers, and are close to main arteries that serve the port's hinterland. In most cases the new projects have a lesser number of ship berths than those being replaced, but the increased efficiency of the functional layout plus larger covered storage areas permit the accommodation of more ships with a quicker turn-around.

The 9½-ft. mean tide differential and a considerable snow load in the winter have placed certain difficulties and restrictions on our terminal designs.

The deck of the shed is designed for a uniform floor load of a minimum of 600 lbs. per square foot and standard highway wheel loads. The cargo doors are of the rolling steel shutter type and have an alternate pattern. The doors are at least 16-ft. high by 18-ft. wide.

Fire Protection System.

Our standard fire protection system for the new piers is a departure from the conventional criteria of the past. The entire shed area is uninhibited by firewalls and the uncertain value of stand pipes and hose racks. The fire protection consists of three more or less interconnected systems: (a) manually-operated fire alarm stations, strategically located throughout the pier and specially distinguished by lights and colour to permit quick location in an emergency, are connected to the city Fire Department alarm system; (b) Central supervisory fire alarm which is connected to the sprinkler system; (c) Pre-action type of sprinkler system with adequate draft curtains, covering every part of the transit cargo shed and offices. Also located around the pier are some hand extinguishers for ambient fires.

The alarm system, when actuated, sets off a large horn which not only alerts everyone on the pier as to a fire but also indicates the exact location. This eliminates any loss of time by the fire-fighting units in locating the fire upon their arrival at the pier. This heretofore new approach to the fire protection problem results from a study of pier fires consistent with a good functional layout and cargo operations. The primary move of the discovery of a fire is to actuate an alarm

Port of Boston, U.S.A.—continued

which will bring trained fire fighting units immediately to the scene, to supplement the protection of the sprinkler system.

The sprinkler system used is the pre-action dry pipe system actuated by rate of rise of ambient temperatures. Hose stations are costly to maintain, and without organised personnel, they become of little use in fighting a fire. Because of the unsteady employment of longshoremen and freight loaders, an organised fire-fighting unit would not be practical.

Lighting System.

The lighting of the piers has been given special study with the view of providing the best illumination as a means of increasing the efficiency of the cargo handling process. There are skylights for daylight hours and incandescent electric lights for night work. The artificial lighting has been designed for low cost installation and operation consistent with the following requirements:—

(1) Maximum utilisation and efficiency of lighting energy
(2) Low cost and ease of maintenance of the system
(3) Uniform distribution of illumination
(4) Minimum depreciation of light from dust and dirt accumulation on lighting units.

Since the interiors of the shed, including structural frame, will be painted with a semi-gloss protective coating, the appearance of the structure and the lighting efficiency are greatly enhanced. The lighting units used in the building are of the heavy duty industrial type, dust and watertight, with wide symmetric distribution refractor lenses.

On the working aprons, adequate non-glare lighting is provided for the safe operation of ship's cargo-handling gear and cargo handling on the wharf. These lighting units are flush mounted on the wall to eliminate damage from, and any interference with, the swinging of cargo between ship and shore. Also, these heavy duty units have high stressed or tempered prismatic refractor lenses for proper light distribution and impact resistance.

Grain Handling Facilities.

Another phase of port commerce which has been of much concern was the modernisation of our export grain-handling facilities, which were about 50 years old. A study of this problem resulted in the decision that the existing Hoosac and Grand Junction grain facilities could be modernised at a cost consistent with the benefits to be derived by the port as the result of being on a competitive level with grain facilities at other North Atlantic ports. The third elevator in the port, the Mystic elevator, was judged to be obsolete and beyond re-habilitation. This elevator was demolished and removed in 1950. The plan for modernising the two remaining grain facilities consists of increasing the ship-loading capacity from 10,000 to 30,000 bushels per hour; provision for loading four ship hatches simultaneously; installation of remote-control power-driven winches for operation of the shiploading spouts; an up-to-date communication and inter-locking conveyor control system; and adequate power outlets for any arrangement of new grain-trimming machines. The modernisation of the Grand Junction grain facilities in East Boston was completed by December, 1951, and of the grain elevator at the Hoosac Pier in Charlestown in April, 1951. The shiploading time of grain cargo has been reduced to less than one-half that required before.

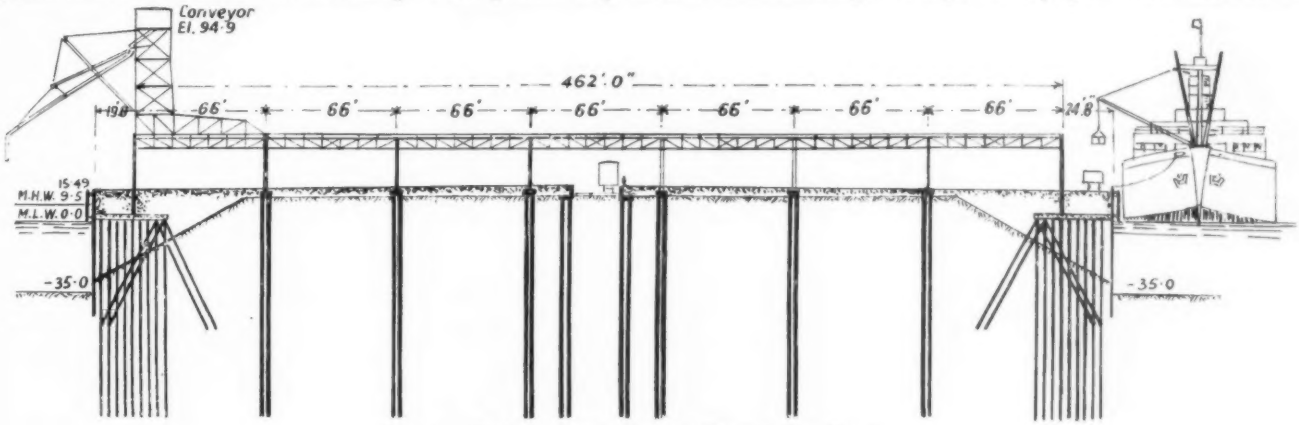


Fig. 2. Typical cross-section of Hoosac Pier No. 1.

DEVELOPMENT PROGRESS

1. Hoosac Cargo and Grain Terminal.

The first step in the Master Plan, was completed on August 7th, 1950, and immediately placed in operation. This large three-berth cargo terminal took almost three years to construct at a cost, including the acquisition of the site and grain handling facilities, of approximately five million dollars. The Hoosac Terminal becomes the first of the large comprehensive covered type of cargo piers in the world to-day. This terminal replaces the former Hoosac Piers known as Nos. 40, 41, 42, 43 and 44. Not only is the cargo handling capacity greater than the former facilities, but it is also much more efficient, and with lower security, administration and maintenance costs.

This terminal has a skew-type finger pier about 550-ft. long by 515-ft. wide, having a fireproof sub-structure, consisting of steel sheet pile bulkhead enclosure with a concrete relieving platform supported on timber piles, a fire-resistant shed, which covers an area of approximately four and one-half acres, has a structural steel frame, bituminous concrete floor on earth fill, insulated flat galvanised steel roof deck with a built-up tar and gravel roof covering, and corrugated cement asbestos exterior walls; an adjacent battery-charging building; the supporting 1,000,000 bushel export grain elevator, and an automatic vehicle weighing scale at the entrance of the terminal for expeditious weighing of commodities passing over the pier. A cross-section of the pier is shown in Fig. 2.

Some of the distinguishing features peculiar to this pier are the 30 by 60-ft. column spacing in the shed, vertical lift trackwell bridge, flat skylights, truck doors for simultaneous loading of six vehicles with certain types of cargo, and ship water supply outlets in underground chambers on the wharf aprons. When the trackwell bridge is in use, a blinking red light both at the bridge and front of the building warns trainmen of the obstruction across the tracks within the building.

The excellent night lighting of the interior is shown in Fig. 3 and of the aprons in Fig. 4.

The battery-charging building, which is located on the westerly end of the terminal, provides facilities for the repair and charging of battery operated handling equipment, and has a large hall for shaping of and paying longshoremen working on the pier. There is also a large open area adjacent to the pier for open storage and the parking of vehicles.

The grain handing facilities have been modernised by increasing the shiploading capacity to 30,000 bushels per hour using two conveyor belts with five simultaneous points of tripping grain providing the latest portable equipment for the bagging of grain at the rate of about 45 tons per hour in the transit shed and motorising the movement of the ship loading spouts. A vacuum cleansing system was also installed to keep the elevator clean and free from dust, as a precaution against explosion, and to insure better working conditions. The vacuum cleaning system has outlets on all floors of the elevator to which portable suction cleaning devices may be connected. The dust and dirt are collected on the outside of the build-

Port of Boston, U.S.A.—continued

Fig. 3. Illumination of the interior of transit shed, Hoosac Pier, No. 1.

Fig. 4. Illumination of wharf working apron, Hoosac Pier No. 1.

ing, and provision is made to load this refuse into freight cars for disposal. With the use of the new belt trimming machines, the trimming of grain in the ship's hold has been increased from 3,000 bushels to almost 15,000 per hour.

There is no congestion of trucks that are waiting to load or take on cargo, such as is usually found at other piers. Trucks can be loaded simultaneously at truck docks at the front of the building and in the transit shed, where a two-way traffic pattern can be attained.

The cost of the pier, including transit shed, trackwork, outside paving, utility building, grain gallery, utilities, fire protection system and dredging and flood lighting, is about $12.30 per square foot of area.

2. Mystic Pier No. 1 Project.

The second step in the Master Plan replaces Mystic Piers Nos. 46 and 47. It was completed in July, 1952, at a cost of approximately $5,600,000, including the purchase of the site. It took approximately 22 months to complete from commencement of demolition of old structures. The general layout and features of the pier are similar to the Hoosac Pier. It is approximately 900-ft. long by 468-ft. wide with 25-ft. working aprons on the side berths and a 20-ft. apron on the outboard berth. The transit shed is a one-storey building occupying a floor area of 246,000 square feet. This pier has a berthing capacity of three ships at one time, supported by a transit shed and one open berth for tie-up or bulk cargo operations. The characteristics and features which differ from Hoosac Pier are : the greater column spacing; three tracks in the depressed well in the centre of the building; the hydraulically operated trackwell bridge which disappears into the track bed when not in use; two long canopied loading platforms connecting to the transit building, one on each side of the well tracks, and ship water supply outlets on the exterior walls of the building instead of in a chamber below the deck of the working apron. The roofdeck is pre-cast lightweight concrete slabs and the skylights are of the gable type. Part of the deck is bituminous concrete fill and the rest reinforced concrete.

The construction cost of the Mystic Pier is about $9.60 per square foot, which is considerably less than the Hoosac Pier. The decrease in unit cost results from maximum utilisation of existing site conditions. The berths of the new pier have been dredged to 35-ft. at mean low water on the two sides and 40-ft. at the outboard end.

The substructure which is a wide reinforced concrete apron supported on long steel H bearing piles around three sides of an earth mole is extremely interesting from both engineering and construction aspects. Because of the existing extremely thick underlying stratum of soft blue clay, the earth mole of the old pier was found to be too sensitive to support the much greater loads required to be imposed by the new structure. In order to eliminate the effect of differential settlement on the wharf building and create a greater margin of stability of the banks of the earth mole, it was found advisable to drive the piles to rock, a length of about 160-ft. In addition, 15,000 cubic yards of local low-cost lightweight aggregate were placed in raising the floor of the mole area about 3-ft. This expedient minimised the effect on the foundation soil from the additional depth of fill. In a period of eight months, about 70 miles of timber and steel piles have been driven, indicating the magnitude of the project and speed with which the work was accomplished. Fig. 5 shows the pile-driving operation going full force with land crane and water rigs.

Special care had to be exercised to avoid the many underground obstructions to the driving of piles. This waterfront area was originally tidal flats when development first started about 100 years ago. Some areas of the concrete wharf apron had to be redesigned to fit a varied pile pattern caused by these unknown obstructions.

Another interesting aspect is the driving of long steel piles through the deck of an existing drawbridge to provide support underneath for part of the pier apron and railroad track approach. Piles were driven through holes cut in the bridge deck, one-half of the roadway at a time, in order to ensure

Port of Boston, U.S.A.—continued

continuous movement of vehicular traffic in this industrial and commercial area.

Fig. 6 shows the terminal upon completion and Fig. 7 shows a typical cross section of the pier.

3. **East Boston Pier No. 1.**

The third step is the proposed pier in the East Boston District. Besides a new pier facility involving a cost of nine million dollars, the project includes the modernisation of the ship-loading grain facilities on Pier No. 4 at a cost of about one-half million dollars.

The plans for the project were completed in 1950, at which time contract bids for its construction were taken. However, waterborne commerce requirements at that time would not permit the withdrawal of the two existing piers, No. 1 and No. 2, from port operations. Therefore, because of this condition and the Korean crisis, construction of the pier was postponed until after completion of Step 2, but the grain facilities modernisation proceeded without further delay and was completed in December, 1951.

The proposed pier has not been changed in basic layout. It is briefly 600-ft. long and 390-ft. wide with 25-ft. working aprons on the side berths and 20-ft. aprons on the outboard end; a transit shed with 20-ft. overhead clearance, covering an area of approximately 196,000 square feet; four sets of tracks, one flush with the deck on each side apron, and two depressed in a well at the centre of the shed; the side berths to have a piping arrangement for the transfer of bulk liquid cargo from ship to tank cars; ramps for vehicular access into the shed; offices, warm rooms, and truck docks will be provided at the inshore end of the building; more parking and open storage area will be provided; a separate two-storey utility building will be built which will house pier cargo-handling equipment repair shops, a gasoline station, and a large hall for the shaping of longshoremen for the work on the pier. A chain link type of fence will be constructed around the entire property to provide the necessary security for cargo and terminal facilities. The cargo working area of the transit shed will be entirely devoid of interior columns, making it the ultimate in modern and efficient operating layouts. The pier will be entirely supported on steel pipe piles which will have a length exceeding 100-ft.

A contract for dredging, demolition and filling has been awarded, and work commenced October 1st, 1952. The remaining contracts will be awarded within three months. The project is scheduled for completion in 1955. Fig. 8 shows typical cross section of this pier.

4. **The Castle Island Terminal.**

This terminal was constructed by the United States Army as a port of embarkation during World War II. It comprises an area of approximately 101 acres, and has potentialities for development into an ideal commercial port terminal. It has a marginal wharf which is 4200-ft. long, with a controlling depth of 35-ft. at mean low water at the berths. There are two existing transit sheds, each 840-ft. long, by 180-ft. wide, one of which is a more or less permanent structure, but too far removed from the caplog for maximum efficiency and flexibility of operation. The other is a temporary wood structure having a close column spacing which prohibits efficient cargo handling and stowage. There are also many small temporary buildings which constitute a fire hazard and will be removed in the first-stage development of the terminal. The roads of the terminal are practically non-existent, as they were originally of a temporary nature. The tremendous classification yard has a total capacity of approximately 650 rail cars. The entire terminal is lighted for night operations by banks of floodlights in structural steel towers located strategically throughout the terminal.

Fig. 5. Pile-driving operations on both land and water, Mystic Pier No. 1.

Fig. 6. View of completed terminal, Mystic Pier No. 1.

The first-stage development plan to convert this terminal into a modern, efficient commercial facility consists of the following improvements and alterations which will involve an expenditure of $1,200,000.

(1) Replace about 1,000 untreated timber piles in the wharf apron which are under-

Port of Boston, U.S.A.—continued

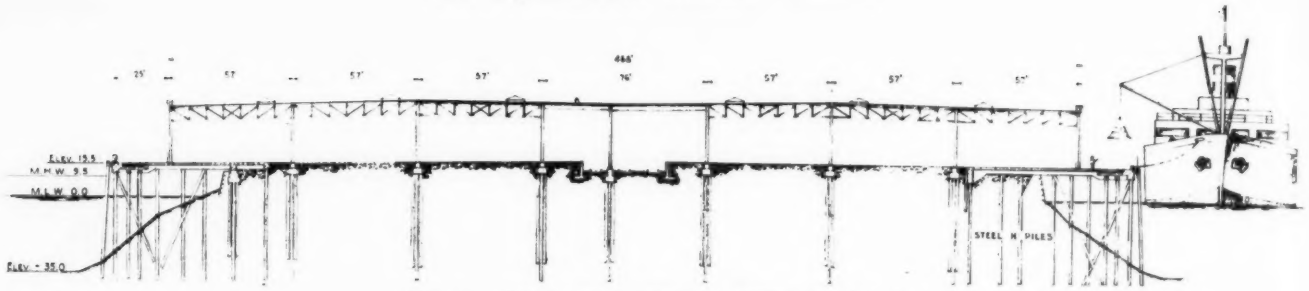


Fig. 7. Typical cross-section of Mystic Pier No. 1.

going a severe marine borer attack. It is proposed to eliminate this inherent weakness and insure the integrity of the wharf by replacing the untreated piles with properly creosoted piles. It is unfortunate that the wartime stress for speed of construction made it necessary to use many untreated piles in the wharf apron.

(2) The demolition of Transit Shed No. 2 and the construction of a new one-storey transit shed of fire-resistant materials, approximately 500-ft. long by 200-ft. wide. The new shed will have offices for Customs, steamship companies, and stevedores; toilet facilities for the longshoremen; a warm room and gear locker, with two shipside tracks flush with the deck and two in a depressed area in the rear of the shed for floor-level loading of freight cars. The rear of the shed will have a 15-ft. wide canopy loading platform, and the track area will be paved to permit handling of truck cargo at the platform.

(3) Transit Shed No. 1 will be extended toward the caplog, a distance of about 60-ft., and increased in length about 180-ft. towards Shed No. 2, in order to provide a better working apron and adequate covered transit storage area for the handling of two ships at one time. Offices will be constructed at each outboard corner of the building for steamship companies and Customs; there will be toilet facilities for the longshoremen, a warm room and a gear locker. The existing wood apron doors will be removed and replaced with rolling steel doors. Skylights will be installed in the roof to provide adequate natural lighting for the interior of the shed and the electric lighting system will be revised to conform to present-day standards.

(4) The removal of all unnecessary trackage and the revision of the existing layout for efficient movement in classification of rail cars consistent with low maintenance. The existing holding yard capacity of approximately 650 cars will be cut down to about 80 cars. The shipside tracks along Transit Shed No. 1 will have to be moved closer to the caplog, in order that ship's gear can handle cargo directly from cars to the hold of the ship.

(5) Replacement of the entire underground water supply system, which has been found to be in very bad condition due to electrolytic and chemical action. This work is necessary to provide an adequate source of water supply for fire protection of the terminal, and for serving the requirements of ships while at the docks.

(6) The existing temporary roads are in very poor condition and require reconstruction on a permanent basis. The entire existing layout of roads will be revised to permit a more desirable traffic pattern, security, and maximum use of the area comprising the terminal.

(7) A single-storey storage building will be constructed in the rear of Transit Shed No. 1 for use as a supporting storage facility in connection with waterborne commerce. This shed will be of one storey, approximately 120-ft. wide by 300-ft. long, with ramps for truck entrance into the sheds, and tracks in a depressed area in the rear of the building to permit floor-level loading of freight cars.

After completion of the first-stage development, consideration will have to be given to further development after complete study is made of the commerce requirements and the economic benefits to be derived from the proposed improvements.

The contract plans have been completed and the work is scheduled for commencement about July, 1953.

Fig 9 shows existing conditions of the terminal.

5. The Northern Avenue Project.

Until World War II, the so-called New York, New Haven and Hartford Railroad Piers Nos. 1 to 4 inclusive, were used for intracoastal trade. During the war and since these facilities have been abandoned and allowed to deteriorate to such an extent that rehabilitation is impractical. This location is ideal for development as a combined passenger and cargo terminal, since it is situated on the Main Ship Canal with a depth of 40-ft. at mean low water; it is sheltered against rough water; the area encompassed would allow an extensive open storage and parking area for cars and trucks; close by is a large railroad classification yard, near the main arteries leading to and from the city and close to the business district of the city and to rail, air and bus transportation. The development of the area would not disrupt any strongly-rooted businesses or require the taking of sound, usable structures. The existing structures are delapidated and present a very unsightly appearance.

The project would consist of one combined passenger and general cargo terminal having a two-storey building approximately 200-ft. wide by 500-ft. long; one general cargo terminal having a transit shed 200-ft. wide

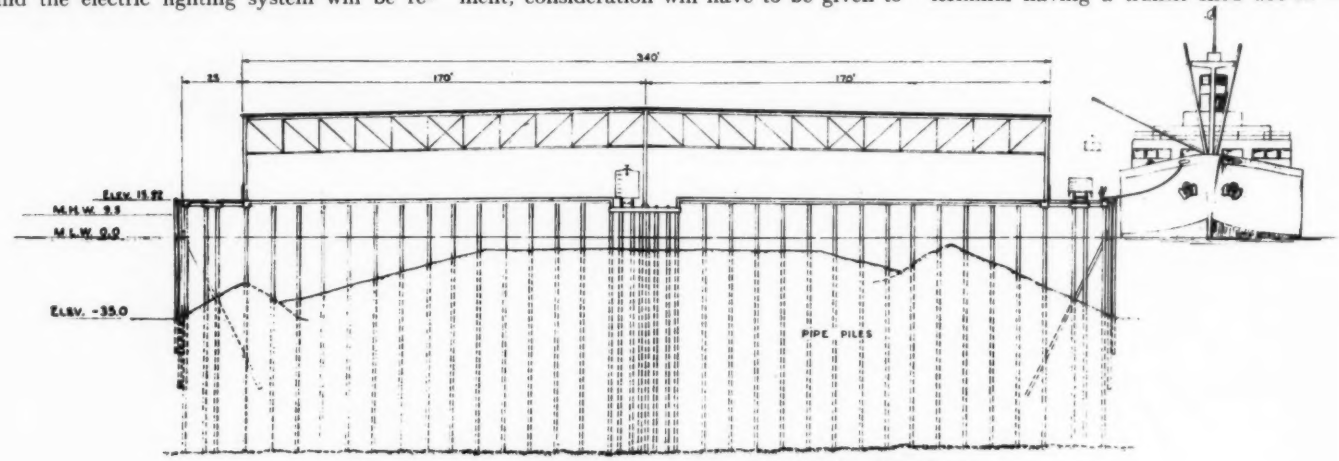


Fig. 8. Typical cross-section of proposed East Boston Pier No. 1.

Port of Boston, U.S.A.—continued

by 500-ft. long; another general cargo terminal having a transit shed 200-ft. wide by 600-ft. long; a three-storey industrial centre building approximately 200-ft. wide by 600-ft. long; a vehicular ramp to the second floor of the passenger terminal; roads, open storage, and a parking area.

The industrial centre would be a three-storey fireproof building having ramps, truck and rail loading platforms, elevators and such other appurtenances and features as would be necessary for efficient and flexible use of the building for commercial, industrial and warehousing operations relative to the maritime trade. An international trade centre is planned to be located on the top floor.

Fig. 9. Aerial view of Castle Island Terminal, showing existing conditions.

The first part of this project which is scheduled for commencement about 1955 is the passenger and general cargo terminal. The passenger service would be exclusively on the upper deck, while the lower deck would be used primarily for the handling of general cargo. The second deck would also include the general offices of the Port of Boston Authority; offices for Customs and steamship lines; a restaurant; waiting rooms; and other conveniences and services pertinent to the passenger trade. There would be a freight elevator for transferring baggage and cargo between the first and second decks. Special attention would be given in the layout to the elimination of the confusion that exists in most passenger terminals because of the intermingling of passengers and visitors and the processing operations of disembarkation and embarkation. The motor vehicular and pedestrian ramp to the passenger terminal, which is to be on the second deck of the proposed new structure, would enable passenger and other operations of the second floor to be carried on independently without interference from the first floor general cargo activities. The large parking area that would be available would permit visitors and passengers to arrive in their private cars. This is an aspect that is sadly lacking at most piers throughout the country.

The economic study made, indicates that the revenue derived from the rental of the actual passenger terminal, the offices and concessions, the parking and the general cargo function would be more than adequate to amortise the cost of the project.

In order to permit expansion of the passenger services facilities when future conditions warrant, the foundations of the transit shed adjacent to the passenger terminal have been designed to carry an 80-ft. wide passenger gallery with an observation mezzanine on the roof. The gallery would be connected to the main terminal by a 100-ft. long second-floor bridge. The maximum length of the passenger terminal with gallery would be 1,100-ft., permitting the accommodation of the largest passenger ships.

The plans have been completed for the substructure of the project. It is estimated that the total cost of this development will be about 15 million dollars.

6. **East Boston Pier No. 3 Modernisation.**

The passenger facilities on the second deck of Pier No. 3 of the so-called Grand Junction Docks in East Boston, now owned by the Commonwealth, should be modernised and placed in service again.

This area, since Colonial times, has been one of the principal locations in the port for the handling of waterborne cargo and passengers. Near the turn of the nineteenth century, the existing Pier No. 3 was constructed as a combination general cargo and passenger terminal. Until the thirties, this terminal enjoyed considerable passenger trade. Since the war, the passenger trade is practically nil, as it is impossible to handle passengers because of the present deplorable condition of the facilities.

A necessary adjunct of any progressive port is provisions for handling waterborne passenger traffic.

Last year, the Authority made a study of the desirability of making repairs and improvements to the passenger facilities of Pier No. 3. It was found that this terminal, as in the case of Commonwealth Pier No. 5, did not keep pace with periodical changes in terminal operation, transportation, and standard of living during the past 50 years. The passenger and freight elevators are obsolete; the stairways are inadequate; there are no waiting rooms; the lighting and ventilation are poor; there is no flexibility in ship gangway locations; and the interior is very unattractive.

To modernise the passenger terminal facilities of Pier No. 3 besides rectifying the deficiencies mentioned above, the passenger galleries, one on each side of the pier, must be widened and lengthened to permit accommodation of larger vessels in the trade and decrease passenger and baggage congestion. The cost of making the necessary alterations and improvements to the existing structure is estimated to be about $400,000. This improvement is expected to get under way after completion of adjacent proposed Pier No. 1.

PROGRESS OF COMMERCE

This seaport serves the tributary area of Boston and New England, extending to the hinterland of up-state New York, the states to the North of the Ohio River, and West of the Mississippi; as well as the Canadian Provinces to the North.

Since World War II, the port has made excellent progress under the guidance of the newly created Authority in developing its waterborne commerce. In 1950, according to the American Merchant Marine Institute, from figures of foreign imports and exports supplied by the Bureau of the Census of the Department of Commerce, Boston registered the largest percentage increase in tonnage and the highest increase in dollar value of cargo handled of any major port in the United States. In volume Boston moved from eighth to sixth place in total tonnage and from eighth to third place in dollar value.

Again, in 1951, a release from the United States Department of Commerce showed a 43% gain in the valuation of shipments through the port during 1951, with a value of $918,600,000. Of this total value $883,500,000 was dry cargo and $35,100,000 tanker ship cargo. Although general cargo imports showed a slight decline in volume, the dollar value increased greatly.

The Dock and Harbour Authorities' Association

Annual Report and General Meeting

The Report of the Executive Committee of the Dock and Harbour Authorities' Association for 1952 was presented at the Annual General Meeting held in London on February 25th last.

After reviewing legislation for the year, as it affected docks and harbours, the report dealt with the Transport Bill, which recently has passed through all stages in the House of Commons. Note was taken of the Government's proposal to repeal sections 66 to 68 of the Transport Act, 1947. The effect of this repeal, if it is passed into law, will be to end the review powers of the Docks and Inland Waterways Executive which have been delegated to them by the British Transport Commission. Where draft schemes have already been introduced they will automatically lapse.

Ports Efficiency Committee.

The Ports Efficiency Committee which (as already reported in this Journal) was set up last March by the Secretary of State for the Co-ordination of Transport, Fuel and Power, have had a number of meetings during the year and have issued two reports drawing attention to the fact that a major obstacle to improving the flow of goods through ports at the present time is the difficulty of securing steel supplies for port works, and particularly for the rebuilding of war damaged transit sheds so as to bring additional berths into commission.

The Committee have also suggested the setting up of Port Operations Panels at the principal ports and considerable progress has been made in the setting up of these Panels.

The Committee are to remain in being so that they can be called into action either by the Secretary of State for the Co-ordination of Transport, Fuel and Power or by the Minister of Transport, or through representations from one or more of the Port Operations Panels.

Port Statistics.

The major ports have for some time past kept detailed statistics for their own use and the Ministry of Transport suggested some time ago that some form of statistics should be made available to them.

The Ports Efficiency Committee have also drawn attention to this matter and as a result the Association have had discussions with the Chamber of Shipping, the Liverpool Steam Ship Owners' Association and the National Association of Port Employers, and a form of statistics has now been agreed.

These statistics will be limited for the time being to foreign-going dry cargo shipping and will be supplied by certain of the larger ports through the port authority to a Joint Committee to be set up consisting of six members, one appointed by the Chamber of Shipping, one by the Liverpool Steam Ship Owners' Association, two by the Association, one by the British Transport Commission and one by the National Association of Port Employers.

It is proposed that this Committee will consider the statistics from time to time and submit their observations to the Ministry of Transport.

Increase in the Size of Ships.

In the earlier part of the year considerable prominence was given to the question of the turn-round of shipping and at the last Annual General Meeting, the President drew attention to the alteration in the type and design of ships and to the fact that the necessity for keeping pace with changes in the type and design from time to time, especially in these days when materials are a difficulty and costs are very high, might put dock and harbour authorities in a position of some embarrassment.

The question was also referred to last year at the General Meeting of the Chamber of Shipping when Mr. R. S. MacTier, C.B.E., moved a Resolution indicating the concern of the Chamber on the question of turn-round and calling for positive action from all those concerned to reduce the present delays. Mr. MacTier stated that, on the physical side, perhaps the most serious defect in the major British ports to-day was the shortage of deep water alongside berths, and in this connection he mentioned that the average length and draught both of liners and tramps had increased very considerably over the past twelve years.

The Association pointed out to the Chamber of Shipping the difficulties with which port authorities are confronted and expressed the view that a proper balance must be maintained between, on the one hand, the desirability of increasing the size of certain types of ships, and on the other hand the difficulties of embarking upon major capital works of port reconstruction and the increased port charges which must inevitably follow such works.

The Association suggested that it might be advantageous to set up some form of consultation between ship owners and port authorities which would operate when any material alteration in the size or design of ships is contemplated. The matter is still under consideration by the Chamber of Shipping, and it is hoped that they will agree to set up some form of consultation which the Association believe might lead to a better understanding on both sides of the magnitude of the problems involved.

Towards the end of the year the matter was carried a stage further when the permanent International Association of Navigation Congresses announced that they were proposing to set up an International Committee to study the depths of water to be provided in sea ports and at their entrances and berths, in relation to the present trends of ship building.

Before setting up this International Committee it was decided to invite each maritime country to set up a national committee to make a preliminary study of these questions, so that the work of the International Committee should be facilitated and data from various countries should be available.

The British National Committee agreed to the setting up of the preliminary committee under the Chairmanship of Sir William Halcrow, M.I.C.E., and invited the Association to nominate a representative.

Annual General Meeting.

At the general meeting of the Association Col. J. G. B. Beazley, chairman of the Mersey Docks and Harbour Board, was elected president in succession to Viscount Waverley, who has occupied the office for the past seven years. Viscount Waverley, who presided at the meeting, recalled that his term of office as president had coincided in a remarkable way with the evolution of Parliamentary legislation on the subject of the Transport Act of 1947.

The adoption of the report and accounts was moved by Sir Douglas Ritchie (chairman of the executive committee) who also touched upon the activities of last year. He said that the prevention of oil pollution, though not mentioned in the annual report of the Association, was vitally important to their members. A committee had been set up under the chairmanship of Mr. P. Faulkner of the Ministry of Transport to consider what practical measures could be taken to prevent oil pollution round our coasts. That committee had not yet reached any conclusions.

On the question of the increased size of ships for which ports had to cater, Sir Douglas said that, as the result of their suggestions that some form of consultation should be set up between shipowners and port authorities which would be operated when any material change in the size or design of ships was contemplated, the Association had received from the Chamber of Shipping an invitation to suggest dates when a conference could usefully take place between the two bodies.

Port of Boston, U.S.A.—continued

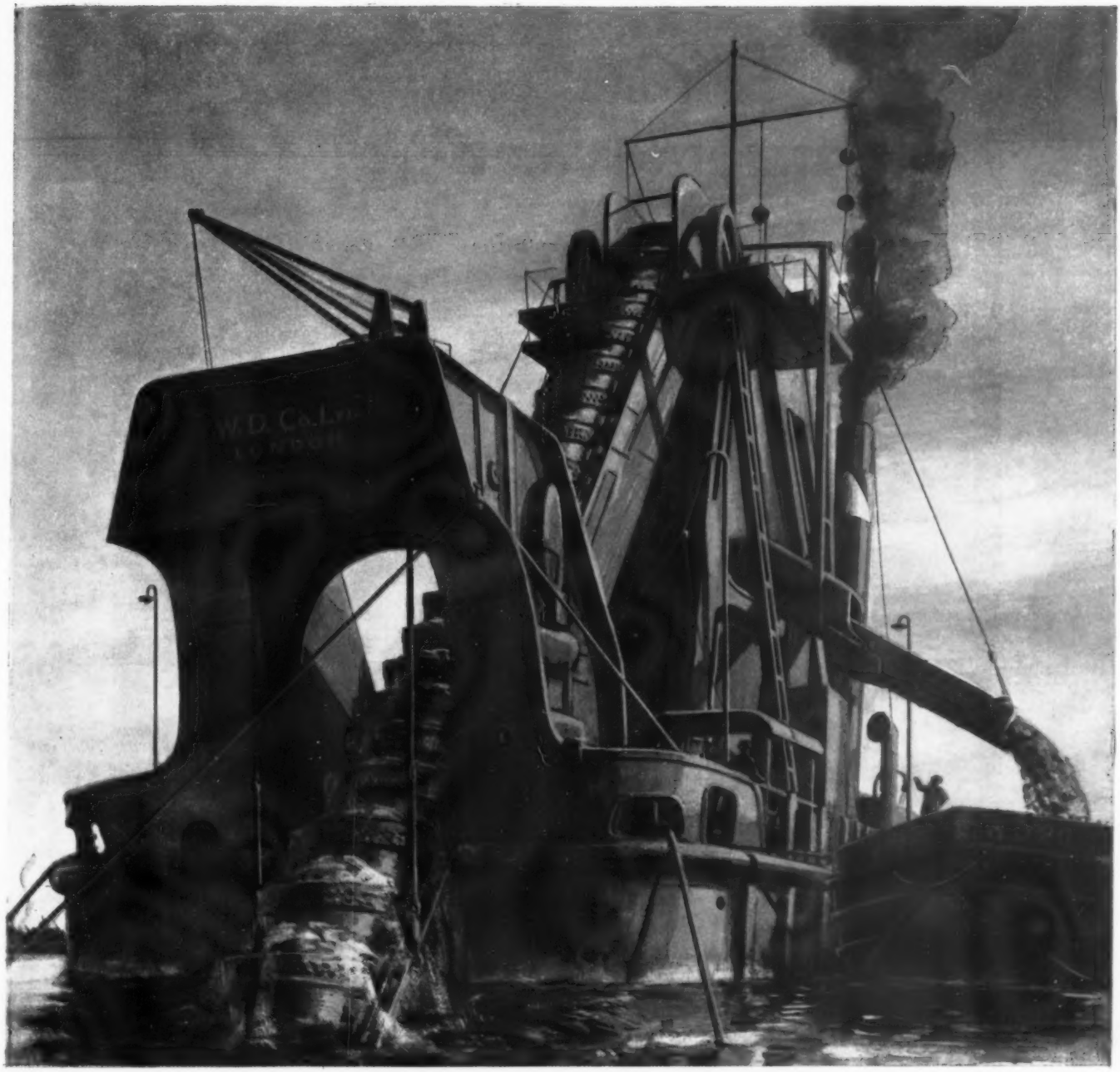
The steady increase of trade in the port since 1945 is clearly shown in the tabulation of imports, exports and domestic commerce which includes coastwise, intercoastal and intraport returns.

COMMERCE OF THE PORT OF BOSTON, 1945-1951, INCLUSIVE

(Tons of 2000 Pounds)

Year	Foreign Imports	Exports	Domestic	Total
1945	1,742,911	565,121	10,542,490	12,850,522
1946	2,819,722	428,950	11,759,662	15,008,334
1947	3,252,695	538,625	14,711,582	18,502,902
1948	2,833,989	319,722	15,263,595	18,417,356
1949	3,448,810	433,419	11,785,323	15,667,552
1950	5,301,528	247,364	12,663,979	18,212,871
1951	5,300,446	436,720	13,239,714	18,976,880

Boston, U.S.A. and Liverpool, England, continue to be the lead-ng wool markets in the world. Some of our principal imports are: petroleum products, raw sugar, wood pulp, canned goods, wool, gypsum, rubber, lumber, vegetable oils, hides and skins, coal and coffee, jute and minerals. A few of the exports are : machinery, grain, paper, wire, cotton, wool goods, fish, chemicals, electronic parts and equipment.



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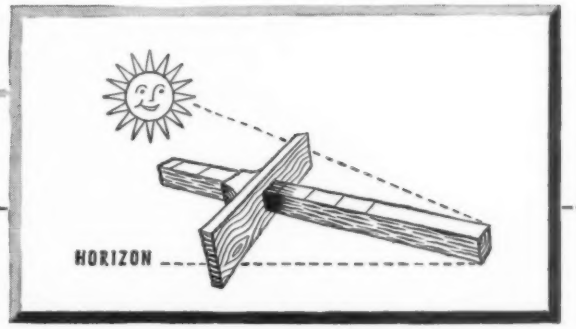

This method of taking altitudes was invented in 1432. Columbus used a Cross Staff but the instrument did not come into common use until the 16th century. Later versions had four vanes and were often carved in ivory.

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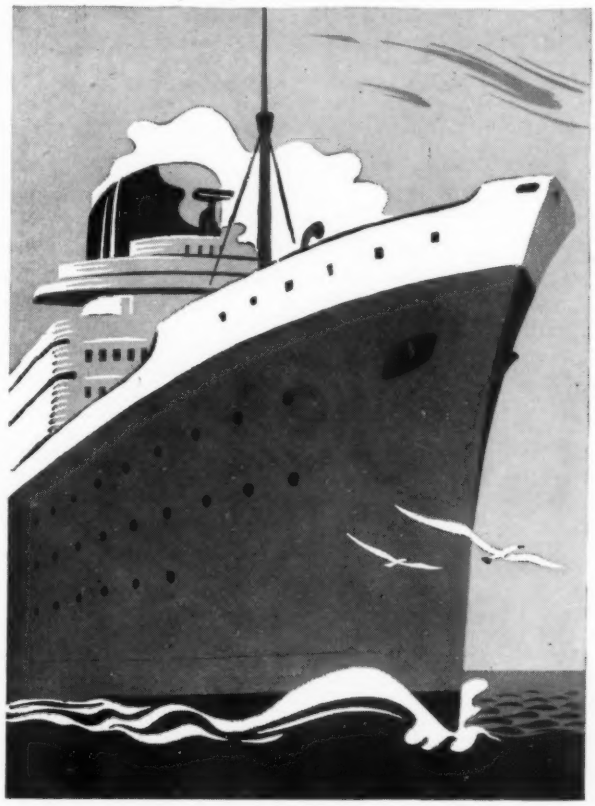

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The Discharge of Bulk Sugar

Mechanical Handling Methods Reviewed

By E. S. TOOTH.

IN sailing ship days and in the early part of this century, considerable quantities of raw sugar were imported into this country in hogsheads—large wooden casks weighing, laden, half a ton each. This type of container later gave way to gunny bags, and bagged sugar has for many years been one of Britain's chief imports. From 1945 to 1949, London's share alone was some 8/900,000 tons per year.

During these post war years, however, the idea of importing raw sugar in bulk into Great Britain was explored, one impetus to research being the shortage of jute, from which the gunny bags were made. In March, 1949, sanction having been sought from the Ministry of Food, the first experimental shipment of bulk sugar, a consignment of just over 5,100 tons, consisting of the contents of about 42,400 bags, was loaded at La Romana in San Domingo into a vessel built for carrying coal. The following month the ship berthed in the River Thames at a jetty equipped with 7½ tons grabbing cranes, normally used for handling coal. The mechanically operated grabs each weighed some 3½ tons, and each could lift more than its own weight of raw sugar. Discharge proceeded and much was learned.

In 1950, 14 vessels brought a total of over 76,000 tons of raw sugar in bulk from a number of different countries—San Domingo, Trinidad, Jamaica, Natal, Fiji and Mauritius—and by the time these consignments had been dealt with it had been established beyond doubt that the carriage of bulk sugar was both satisfactory and economical. All these shipments were discharged at Thames-side wharves equipped with heavy duty grabbing cranes and all the sugar was taken to Messrs. Tate & Lyle's refineries.

This experimental period needed the goodwill and the co-operation of a number of interests, including the Port of London Authority, H.M. Customs and Excise, Shipowners, Brokers and Discharging Agents. Among the theoretical certainties which practice confirmed was that the best type of sugar carrier is the self-trimming vessel. If large quantities of sugar were to be imported annually in bulk, however, it was also obvious that many general cargo vessels would have to be employed—and that fact brought to the forefront the problem of trimming.

Grabs as the Primary Means of Discharge.

The quantity of bulk sugar brought to London increased from 276,000 tons in 1951 to approximately 650,000 in 1952, the latter figure representing two-thirds of London's total for all sugar, bulk and bagged.

Bulk sugar is now being imported into Great Britain in ships of a variety of types and sizes from Australia and British Guiana as well as from the countries already mentioned, at the rate of a million tons a year. Some of the ships are suitable for river discharge, some for the docks. Wherever they have berthed, however, the primary appliance for discharge has been the grab. It must be emphasised at once that the discharge of bulk sugar is certainly still in the experimental stage. No better discharging appliance than the grab, whether dumping or mechanically operated, has yet been found. The bigger the grab (up to a certain limit), the greater the output and speeds of discharge. Between 50 tons and 100 tons per gang hour are usual.

In London, discharge is mainly to barges, many of which have been built specially for carrying bulk sugar. In Liverpool, the beginning of the traffic marked the first phase of long-term developments planned by Messrs. Tate & Lyle with the co-operation of, among others, the Mersey Docks & Harbour Board. At the Huskisson Dock, dumping grabs discharge the sugar into mobile overhead hoppers, each of 25 tons capacity, installed on the quay behind the line of the crane tracks. The sugar is then drawn off into container vehicles which take their loads to the refinery in the vicinity. Discharge and despatch are smooth and speedy.

Whether the sugar is delivered overside to barge or "landed" into hopper, the grab, then, is the means by which it is taken out of the ship. Particularly with general cargo vessels, however, it is by no means the only mechanical appliance necessary if a good speed of discharge is to be maintained. Before the grab can pick it up, sugar in under-deck stowages, both in the lower hold and in the 'tween decks, must be trimmed into the square of the hatch and manual trimming, besides being arduous, is far too slow.

It is true to say that the biggest problem at the present time in connection with the discharge of bulk sugar is to find suitable trimming machines, particularly to cope with the variety of working conditions found in general cargo vessels.

Factors Affecting Discharge.

To put this point in proper perspective, the position can be stated thus. Apart from the quality of (a) the organisation and (b) the available labour (and the importance of these cannot be overstressed), the speed and cost of discharging bulk sugar ex ocean-going vessels is, under existing conditions, controlled by four main factors, viz.: (1) the capacities of crane and grab, (2) the condition of the sugar, (3) the type and size of ship, and (4) the efficiency of the trimming appliances available.

In connection with factor (1), there is undoubtedly a technique to be perfected in the primary work by grab. If big holes are left as discharge proceeds, it is often difficult to land the grab fairly and squarely so that it will pick up a full load. Indeed, the dumping grab particularly will sometimes fall on its side and valuable time will be lost righting it. In theory, the grab and trimmers should work to maintain a level bed of sugar; in practice this may be difficult, especially if the need to use trimming machines on the ceiling at the earliest possible moment is to be kept in mind.

The condition of consignments of bulk sugar (factor (2)) from the same country of origin and even from the same loading port, varies considerably. Sugar will cake in the hold according to the atmospheric conditions under which it is loaded and the conditions of ventilation and temperature under which it is carried. The precise effects of various conditions are being studied. Those of carrying may be the more important. If so, it is fortunate, for they may also be the more easily controlled. Since sugar has been transported in bulk between the raw factories and the refineries, Messrs. Tate & Lyle have made world-wide enquiries and investigations to try to improve its consistency so that it is as free-running as possible. When sugar cakes, veritable "cliffs" as much as 25-ft. high, are sometimes left in the hold by the operation of the grab and these are often difficult to break down. Even under the plumb of the crane, caked sugar can cause delay and it is often efficacious to fit teeth to the grab, which then obtains a better bite. However, if sugar is loaded and carried under the right conditions (to be determined) it should only be seldom that the discharging agent is presented with the problem of handling a troublesome proportion of caked sugar.

Factor (3)—the size and type of the carrying vessel—has also a big effect on the speed of discharge. Between decks, alleyways, stanchions and confined spaces (such as between propeller shaft tunnels) all have a retarding effect—as of course will the overstowing with bulk sugar of piles of ship's dunnage and hatchcovers, and of spare propellers and other obstructions to the work. As important a factor, however, as far as the vessel itself is concerned, is the size of the hatchway compared with the dimensions of the hold. Obviously, the bigger the deck opening the bigger the quantity of sugar which does not need to be trimmed, and it is during the time the grab can collect a full load of sugar without ever having to wait for the trimmers, that the highest outputs are obtained. These statements, it must be made clear, are true only while the grab remains the primary means of unloading. If dis-

The Discharge of Bulk Sugar—continued

charge were ultimately to be done satisfactorily by, say, suction plant or conveyor, they would not stand.

Trimming.

The aim of all good discharging agents is to keep up the highest rate of discharge for the longest possible time and it is for this reason that trimming is so important. The handling of raw sugar in bulk effected initial economies which were deemed satisfactory; but trimming, which must be done both at loading and at discharge, can be costly. At discharge, sugar has to be cleared out of recesses and odd spaces into which it has seeped by pressure, by gravity and by the motions of the ship at sea. Ships are being built, designed for easy loading and discharging, so as to reduce trimming time and costs to a minimum. Some of the biggest of these have a carrying capacity of about 8,000 tons of raw sugar in bulk and will carry sugar from the producing countries to Liverpool.

Despite these plans, many general cargo vessels will still be required for the traffic and in these ships much trimming, both manual and mechanical, will still be necessary. The manual means employed vary according to the working conditions and among those found effective are shovels, spades, pickaxes, rakes, scrapers and pitch forks. Rakes may either have the conventional teeth or be constructed on the squeegee-scraper principle. Both types are useful in various circumstances. The forks are often particularly useful for trimming sugar in a hard condition, but equally as effective are pneumatic hammer units fitted with clay shovels. Pneumatic drills have also been used on hard sugar with some success, but it must be emphasised again that conditions vary through such a wide range that appliances which are satisfactory for one shipment, or even for one hold, are not necessarily suitable for another. Where 'tween deck cargo has been completely inaccessible to trimming machines, the ordinary builder's wheelbarrow has often been usefully employed to convey sugar to the 'tween deck coamings and to tip it into the square. Another means of trimming from the wings into the square is the sugar plough. These tools are made in several shapes—one type is a ploughing fork—and are operated by ship's winches. Since, however, the wire for hoisting must be rigged horizontally, it tends to delay the hoisting and lowering of the grab. Moreover, the use of this winch-operated plough is uneconomical with labour. The minimum team is four men, two with the plough, a hatchwayman and a winch-driver. Sometimes an additional signalman, stationed in the 'tween deck, is also required. For these reasons, therefore, the plough is not widely employed.

A simple expedient which has been tried in the London Docks particularly to break down cliffs of hard sugar, is the driving into the bulk of steel tubes having a covering of rubber of high elasticity. The rubber tubes are then inflated with air until they burst. The experiments have had little success. Proposals considered with the same purpose in view include the placing of baulks of timber in opposite wings of the holds before loading commences. These would be stood upright and when convenient during the loading process would be joined together, at their top ends, by stout wires. When a suitable point had been reached in discharge, winch power would be employed on the connecting wires to draw the baulks together and it is hoped that a good fall of sugar would result. A proposal explored by the Port of London Authority concerned the fragmentation of caked sugar by explosive cartridges, but this was not satisfactory to the refinery experts. The suggestion has also been made that caked and hard sugar could often be broken down by the vibration of the ship's hold. So far as is known, this method has not yet been tried, although unsuccessful experiments have been made using a vibrator on the sugar itself. However, as already stated, the main hopes of solving the problem of caked sugar revolve round the study of the conditions which cause it.

Trimming Machines.

Experiments with trimming machines have been interesting and instructive. In the earliest shipments it was obvious that manual trimming was not going to be adequate. It was work which might be done at 5 tons to perhaps 15 tons per gang per hour but its speed varied tremendously according to working conditions. A speed of at least 50 tons per hour was needed and there were no trimming machines made especially for bulk sugar. The first appliances tried therefore were some of those made for civil engineering work such as site clearance and building construction, the mechanical diggers, shovels, loaders and dozers.

Any of these machines, to be of use, had to fulfil three important conditions. They had to be light enough to lift aboard, heavy enough for their wheels or tracks to gain effective adhesion on the ceiling or 'tween deck, and manœuvrable enough for speedy work. Once they were aboard and working, much care had to be exercised to avoid damage to the ship. Caterpillar tracks can damage hold ceilings and 'tween deck fittings; buckets and scoops can sheer off bolt heads. These were important matters, particularly bearing in mind that the use of grabs also carries with it a heavy risk of damage to the vessel.

Some of the machines which early proved of use were the dozers—bulldozers, calfdozers and angle-dozers. An example of these is the Bristol 20 Angle-dozer, a light petrol- or kerosene-driven machine weighing 2 tons 5 cwts., having a narrow gauge track of

Demonstrating ability of British Angle Dozer to work round and between vent shafts, samson posts etc. in clearing 'tweendeck areas for grabs in main hold. Note also ability to lift material over comings.

29½-in. and a 5-ft. steel blade, which can be angled from the operator's seat and can be raised while the machine is in motion. A larger model has a 44-in. gauge track and a 6-ft. blade and weighs 2 tons 7 cwts. Both machines were successful in trimming sugar from 'tween deck to lower hold at speeds of up to 50 tons per hour, but the larger machine had restricted use. On the ceiling of the ship, a disadvantage of both machines is that, although they are reversible, they have to turn round in the process of trimming, an operation which takes time and thus reduces the tonnage handled per hour. A longer blade on the angle-dozer can under-cut a cliff—and under-cutting is obviously a good method of dealing with obstinate sugar. Calfdozers used at Liverpool have been fitted with a specially wide flat blade, hinged in the middle so that the two halves can be adjusted independently to any angle. They successfully cut sideways into heights of sugar.

The conventional mechanical scoops and bucket loaders have also been found useful but with these, perhaps even more than with the dozers, manœuvrability is a vital factor. The Muir-Hill hydraulic loader is an example of this type of machine. Diesel- or petrol-driven, it is a lightweight mechanical loader normally used for loading sand or ballast into road conveyance. It has four pneumatic-tyred wheels (preferred by ships' Chief Officers to tracks!) a turning circle of about 15-ft. and two speeds forward

The Discharge of Bulk Sugar—continued

Muir Hill Loader working between decks in ship's hold, discharging bulk sugar.

and two reverse. Its maximum length (which varies according to the position of the bucket) is 10-ft. 4-in.; its maximum height (bucket raised) 9-ft. 1-in.; its overall width 4-ft. 3-in. Bucket capacity on the standard model allows it to lift just over 5 cwts. of sugar. Each model, petrol and Diesel, weighs under two tons and is thus convenient for lifting aboard. The Muir-Hill has been found capable of trimming bulk sugar in 'tween decks and lower hold at a speed of some 30/40 tons per hour and it can sometimes be used where a dozer cannot.

A similar appliance which performed satisfactorily in trials is the Coventry Climax Diesel-powered Bulk Loader. It has heavy duty pneumatic tyres fitted to both front and rear wheels, simple car-type controls, two speeds forward and two reverse. High speed forward is 10.15 m.p.h.; reverse 14.7 m.p.h. The machine has a wheelbase of 53-in. and a turning radius of 83-in. It is 128-in. long, 61-in. high, and weighs 4,350 lbs. The bucket will carry approximately 6 cwts. of sugar. It is calculated that, in favourable conditions—i.e. with a good bulk of cargo near the square of the hatch—this bulk loader will trim sugar at speed of 30 tons and more per hour.

These " front end " loaders are certainly efficient machines but, particularly in the lower hold, they must often turn completely round before shooting their loads. Moreover, they must sometimes wait for the grab to be hoisted clear. This manœuvring and waiting uses valuable time and, in the attempt to find a machine which could perform the operation more simply, attention was turned to the overhead loader.

Trials have been made with the Merton Overhead Loader and may be made shortly with the Eimco Rocker Shovel. The standard model of the Merton was not completely suitable for work on sugar in a ship's hold, although trimming speeds of around 50 tons per hour were achieved when work was proceeding near the square of the hatch. On this machine the bucket, after loading, automatically traverses the superstructure along a track and is then tipped in the rear. Whilst this operation is taking place, the machine can reverse, thus permitting the load to be deposited at a considerable distance from the digging point with little loss of time. The bucket can dig at various angles but is, of course, held vertical between loading and discharge. A new model, modified so as to be specially suitable for bulk cargo handling, is in course of construction. The modifications include a redesigned bucket of 10 cwts. capacity and fitted with teeth; a safety glass window in the superstructure for the benefit of the operator; heavy duty, water ballasted tyres—to ensure maximum tractive effort; improved steering to ensure minimum turning radius; electric road lighting and horn; and the provision of slinging eyes (4-point suspension) on the chassis. Its working speed for bulk sugar is estimated at some 70 tons per hour, whilst operating near the square of the hatch but decreasing, of course, as the distance to be traversed increases.

Close-up view of the Merton Overhead Loader.

The " Eimco," a machine of American manufacture, is also an intriguing proposition as a sugar trimming appliance. Powered by either a Diesel or electric motor, it is a crawler-mounted rock loader with low head-room requirement—(8-ft. 6-in.)—being normally supplied for underground working. Rubber track pads could be fitted if expedient. It has five speeds forward and one reverse, and the manufacturers claim an operating speed at 4 to 5 bucket-loads per minute. A bucket for bulk sugar might be of $\frac{3}{4}$ cu. yard capacity (about 13 cwt.) and, at the speed of operation claimed, this loader should trim sugar at speeds initially of 75—100 tons per working hour, but decreasing as the appliance worked its way under deck. The machine weighs, however, 15,000 lbs. and to lift it aboard would sometimes create difficulty.

All the trimming machines so far mentioned have to push or carry their loads to the square of the hatch at some time during discharge. Moreover, before they can commence work, they require clear floor space on which to operate. The standard Merton, for instance, wants 17/20 square feet and is thus more suitable for work in the lower hold. Carrying or pushing loads takes time and, apart from suction plant and conveyors, the only way to save some of this time would be to throw the sugar into the square mechanically. The Sinden thrower is an ejector machine which would do this, with a proviso. It is small, compact and electrically driven, the principal element being a short belt which revolves at high speed. The elevation of the belt can be altered, thus controlling the height and distance to which the sugar can be thrown. The distance can be 50-ft. and more. The proviso is that a suitable method must be found of feeding the thrower's hopper mechanically. If this could be done, a solution of the trimming problem might well have been found, particularly if the feeding and throwing apparatus could be incorporated into one machine. A bucket elevator has been considered for this purpose but a model small enough to work in the hold is deemed not to have the required capacity. The possibility of using the Merton Overhead Loader to feed a thrower is at present being considered and it is probable that a joint test of these two machines will shortly be made on a bulk sugar ship in the London Docks.

Besides the potential saving in trimming time, an important advantage of the thrower is that the machine itself would not have to encroach upon the square of the hatch and would therefore not interrupt the working of the grab.

Suction Plant and Conveyors.

It is also feasible that some sort of " link " conveyor might feed the Sinden thrower but it is more likely that if this type of conveyor were found useful it would be employed as a separate unit. The moving part of this machine is a precision bush chain carrying rocking or trailing flights. The commodity handled is drawn into the steel trunking through inlets—which can be multiple if required. Very little experience has yet been gained in this country in handling bulk sugar in this manner but, if the conveyer could deal with raw sugar satisfactorily and could also be ade-

The Discharge of Bulk Sugar—continued

quately fed, outputs of up to 40/50 tons per conveyor per hour could be expected. If three or four machines could serve each hold, a revolution in the method of discharging bulk sugar would indeed take place.

A similar revolution could result if the present investigations into discharging sugar by pneumatic elevator were to bear sufficient fruit. The first important experiment in this country with this plant was made in Liverpool towards the end of last year. The principle of the experiment was virtually the trying out of a vacuum cleaner to transfer a bulk of sugar from one barge to another. Suction pipes, suspended from the elevator derrick arms, were placed on the bulk sugar, which was sucked through the "camel," the intake at the end of each pipe. The sugar was in free running condition but it was, of course, necessary for men in the first lighter to trim it towards the camels. It then passed through the elevator's hopper and was discharged through a single large pipe into the second lighter at the rate of about 50 tons per hour. The use of suction plant, however, affects the crystal formation of the sugar, which in turn might make it unsuitable for the subsequent refining process. The refinery experts will decide—and, if the employment of the suction machine is permissible, even though it might not be effective enough to supplant the grab as a primary means of discharge, it could well become an ancillary appliance for discharging sugar inaccessible to the grab. At the very least, it might become a good means of "clearing up." A conventional grain machine, however, would probably not have the desired capacity. A suction plant for handling sugar speedily must be large and must have a high horse-power.

How a suction machine would cope with caked sugar is, however, a question which cannot be answered with much optimism. As a fact, a machine which is wholly satisfactory for breaking down cliffs of caked sugar has not yet been found, but one idea yet to be tried out is a front-end loader with its scoop or bucket adapted and inverted. A proposal which is being actively investigated by the Port of London Authority is to use a belt conveyor in conjunction with a bucket machine. The buckets on the latter would be inverted and would cut down the sugar on to an inclined steel chute, which would feed the conveyor belt. This in turn would deposit the sugar in the square of the hold. The conveyor would be mounted on a chassis, the wheels of which would be activated so that the appliance would tend always to move forward into the sugar. This composite machine would appear to be suitable for free running sugar—and, with caked sugar, it would not be of great importance if a fall of sugar took place at the cutting end of the appliance.

There is need for further experiments in this field also but one certain fact which emerges from the investigations so far made into the whole question of the discharge of raw sugar in bulk is that each discharging agent will have to have at his disposal a range of wheeled or tracked mechanical appliances as well as a number of types of manual implements.

The Quick Turn-round of Ships.

It is clear then, that so far, the grab is the only appliance which has proved satisfactory as a primary means of discharge. It is equally clear that so far, every known trimming device has been tried—manual and mechanical—but their capacity to keep the grab served is frequently insufficient. Towards the end of discharge, resort is often made to buckets, skips or canvas "slings," and although these means at this stage often achieve better outputs than grabs, they are of necessity comparatively slow.

In ship discharge, quick turn-round is still of vital importance. Prior to the last war, shipowners spent some 40 per cent. of their outlay on ships in port; now the proportion is calculated at 50 per cent. to 70 per cent. and every organisation interested in the efficiency of our ports is keenly aware of the need to regain the ground lost.

Prompt starts and a full working day are therefore more than ever desirable and to assist to achieve these, canvas hold covers ("tents") are usually provided by discharging agents. These can be removed and replaced much more quickly than sets of beams and hatches, thus extending the actual working time for the grab and the trimmers. Should very bad weather stop the work (bulk sugar may be discharged in ordinary falls of rain in England), the "tents" again save useful time.

Another means of saving time which is being explored is the employment of deck hoppers when discharge is to barge. The principle to be exploited here is that higher outputs result from shortening the slewing motion of the crane. The difficulty is to build a hopper which is not too high for the grab to plumb and at the same time not too low to incorporate (a) the steep-angled sides necessary for the sugar to flow, and (b) means to feed the sugar from the outlet of the hopper over the ship's side into barge. It has to be borne in mind, too, that it is not always convenient during discharge—especially at a crane berth—to have to move barges along the ship's side as they are filling up with cargo. Thus it is best if the angle of direction of flow of sugar from hopper to barge can be varied as required.

Time will also be saved when a technique of discharge is generally employed which takes into account the two somewhat conflicting factors connected respectively with grab operations and trimming machines. There is the need to keep a level bed of sugar, particularly for dumping grabs, whereas there is also the need early in discharge to clear adequate space on the hold ceiling for trimming machines to commence operations.

From the foregoing it will be appreciated that opinions (and those expressed are, of course, the writer's) upon how the method employed to discharge raw sugar in bulk will develop, must be expressed cautiously and certainly provisionally. For one thing, as already emphasised, this work is still very much in the experimental stage; for another, there are several different interests involved, each seeing the matter from a different angle. The shipowner wants his ship quickly clean and undamaged (by grab or trimming machine); the discharging agent wants good outputs but, to be sure of getting them, must have available a range of machines to cover the various circumstances with which he has to deal; the machine manufacturer has to provide machines which comply with the demands of the discharging agent for speed and efficiency of operation and for lightness and manœuvrability—a tall order; the sugar refiner wants the sugar crystals undamaged.

The Present Picture.

The present picture, however, is approximately this. The grab is the current means of discharging bulk sugar from ship. A technique of discharge, which entails co-ordinating the needs of the grab with those of trimming, has not yet been generally perfected. The grab might in due course be supplanted by suction machine or conveyor. Whatever the discharging appliance, however, trimming will always be necessary—certainly in general cargo vessels. The condition of sugar and the construction of vessels vary so much that a wide range of manual implements and mechanical appliances must be available for trimming. The problem will be simplified if sugar does not arrive caked; thus the causes of caking are being carefully investigated.

Only one or two machines have so far been made specially for trimming sugar and no universal machine for the purpose exists. For the time being, however, the overhead loaders are likely to be the speediest in lower holds and the front-end loaders and the dozers in 'tween decks. The mechanical throwers have great potentialities. Experiments are proceeding and there is scope for striking developments.

Gold Coast Railways and Harbours.

The Governor of the Gold Coast has announced that the railways and harbours of the Colony, which at present are owned by the Government and are administered by the general manager of railways, will some time this year be transferred to a public corporation.

New Ports for Guatemala.

With only one Caribbean port (Puerto Barrios) capable of handling ocean-going ships at dockside, Guatemala is planning the construction of two more ports, at a cost of about $10 million. The new harbours would be built at Santo Tomas, and at the mouth of the Sarstoon River, on the British Honduras-Guatemala border.

Simple Earth Stability Investigations*

By J. BRINCH HANSEN.

Introduction.

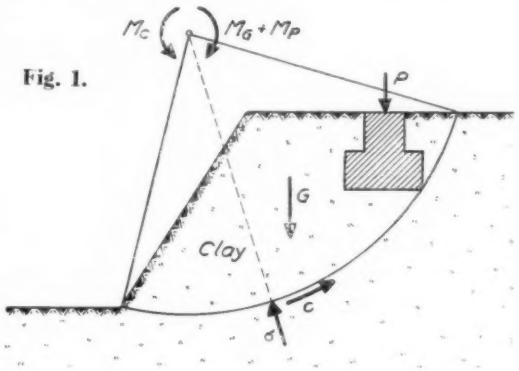
For any structure founded on or in earth a proper design should include a stability investigation, i.e. an investigation of the safety against earth slides involving part or the whole of the structure. As a matter of fact, such investigations should be started as early as possible, because there is, of course, no sense in detailing the different members of a structure until one is reasonably sure that the structure, as a whole, will be stable.

The necessary basis of any stability investigation is a proper investigation of the soil conditions, notably the shear characteristics of the different layers. For *clay* the *shear strength* should be determined, usually in the so-called undrained condition. This can be done in the laboratory by means of unconfined compression tests or triaxial tests, and at the site by means of vane tests. For *sand* the *friction angle* must be known, and for this purpose shear box tests or triaxial tests can be used in the laboratory, when care is taken to use samples with the same porosity as that existing in the ground. At the site deep-sounding cone tests can be made, and approximate values of the friction angle can then be found by means of the graph given in the author's article in CN-Post No. 13 (May, 1951).

Frictionless Earth (Clay).

In frictionless earth *circles* are used as rupture-lines. Fig. 1 shows an example, in which a strip foundation on top of a clay slope is investigated. An arbitrary circle is chosen and the earth mass above this circle is considered. The moments about the centre of the circle are then taken of all forces acting upon this earth mass. The selfweight G of the earth (and the structure) gives a moment M_G, and the load P on the structure a moment M_P. Further, the shear stresses c in the circle give a moment M_c, whereas the unknown normal stresses in the circle give no moments.

Fig. 1.



Now the safety factor for this particular circle is defined as follows:

$$n = \frac{M^c}{M_G + M_P}$$

Other circles are then investigated in the same way, until the critical circle, i.e. the one giving the smallest safety factor, has been located with sufficient exactness. The corresponding safety factor is the actual one.

In the general case, the circle involves 3 independent variables, viz. its radius and the two co-ordinates of its centre. However, in many cases one or two points of the critical circle are fixed in advance, reducing the number of variables to 2 or 1. In Fig. 1, for instance, the critical circle must go through the lower rear edge of the foundation, and probably also through the toe of the slope. If a considerably firmer layer is present at a reasonable depth, the critical circle will probably have this layer as a tangent.

*Reproduced from the November 1952 issue of C.N. Post, by kind permission of Messrs. Christiani and Nielsen, Copenhagen, Denmark.

In the case of a *foundation on piles*, such as the silo shown in Fig. 2, it is usually necessary to locate two different critical circles, viz. one going clear below the piles and one intersecting them. For the latter circle the stabilising effect of the intersected piles can be calculated by means of the method indicated by the author in CN-Post No. 3 (November, 1948). This method must be used with considerable caution, however, and the nominal safety factor, without regard to the piles, should never be less than 1.0.

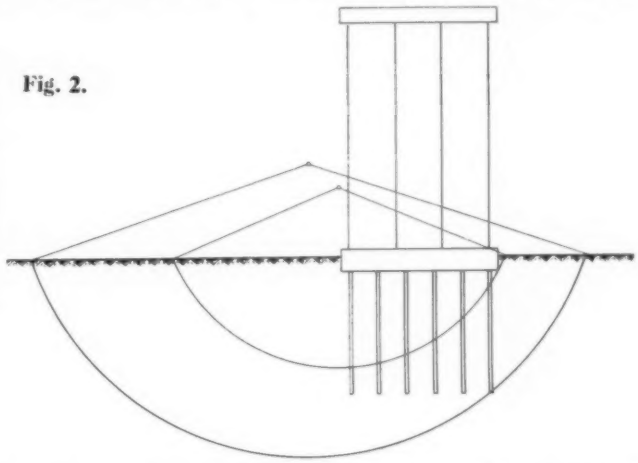
Cohesionless Earth (Sand).

In earth with internal friction *logarithmic spirals* can be used as rupture-lines. Such a spiral is a curve with the polar equation:

$$r = r_o e^{v \tan \varphi}$$

and it has the property that the radius-vector to any point makes

Fig. 2.



an angle φ with the corresponding normal. This means that in cohesionless earth the resulting moment about the pole, of all internal forces in the spiral, is zero.

As the safety factor should be applied to tan φ the investigation is not carried out with spirals corresponding to the actual friction angle φ, but with spirals corresponding to a smaller angle φ' defined by:

$$\tan \varphi' = \frac{1}{n} \tan \varphi$$

If, for example, the actual friction angle of the soil is 35°, and a safety factor of 1.5 is required, then the investigation should be made with spirals corresponding to $\varphi' = 25°$.

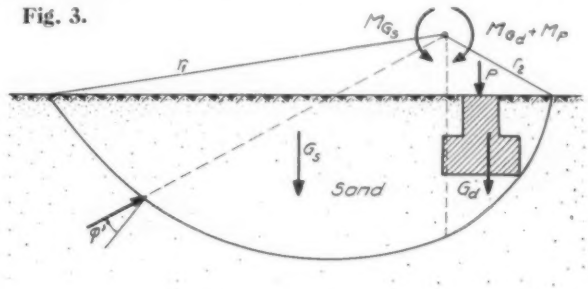
It is practical to have templates of spiral corresponding to angles of f. inst. 15°, 20°, 25°, 30°, 35° and 40°.

Fig. 3 shows an example, in which an ordinary strip foundation in sand is investigated. A spirals corresponding to the proper angle φ' is selected and placed in an arbitrary position. The moments about the pole are then taken of all forces acting upon the earth mass above the spiral. When using a spiral, it is necessary to split up the selfweight G of the earth (and the structure) in a driving part G_d and a stabilising part G_s. A certain ratio f is now defined by:

$$f = \frac{M_{G_s}}{M_{G_d} + M_P}$$

Other locations of the spiral are then investigated in the same way in order to find the critical spiral, i.e. the one giving the mini-

Fig. 3.



Simple Earth Stability Investigations—continued

mum value of f. As the safety factor n has already been introduced by using a spiral corresponding to the angle φ', f is not the safety factor. However, if the minimum value of f exceeds 1, this shows that the actual safety factor is greater than n. Otherwise it is smaller than n.

If, in addition to the internal friction, the earth also possesses a certain *cohesion* c, this can be taken into account in the following way. First, c is divided by the safety factor n, giving $c' = c:n$. This cohesion gives then a stabilising moment:

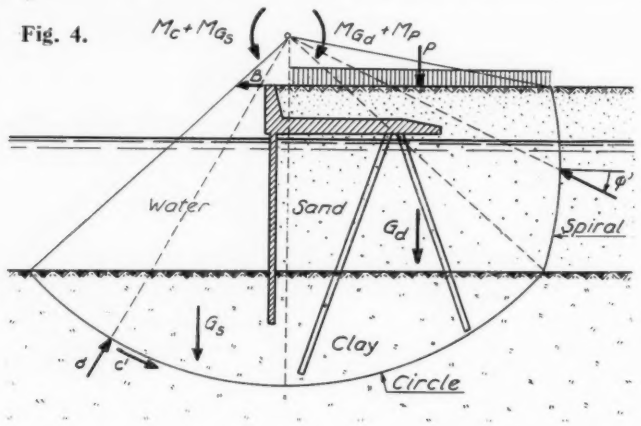
$$M_c = \frac{1}{2} c' (r_1^2 - r_2^2) \cot \varphi$$

where r_1 and r_2 are the radius-vectors to the ends of the spiral ($r_1 > r_2$). M_c should then be added to the stabilising moment M_G.

Effect of Water Pressures.

In the case of *hydrostatic* water pressures, i.e. a horizontal water table, the weight of the water above the rupture-line is in equilibrium with the water pressures in the rupture-line. This is true for any shape of the rupture-line, including circles and logarithmic spirals. Consequently, the water weights and pressures can be

Fig. 4.



completely disregarded in the stability investigation, provided that the *buoyed* specific weight of the earth is used below the water table.

If the water table shows a *capillary* rise (in fine sand), the buoyed specific weight should be used also in the capillary zone, but in addition a surcharge should be considered, acting at the top of the capillary zone. This surcharge should be equal to the height of the capillary rise times the specific weight of the water. In clay the same result can be obtained in a more simple way, viz. by disregarding the capillary rise completely.

In the case of *hydrodynamic* water pressures, i.e. moving ground water, it is usually necessary to first work out a flow net, determining the water pressure at any point. The stability investigation must then include the water pressures in the rupture-line, as well as the water weights above this line. However, this is considerably more complicated than the simple stability investigations dealt with in the present article.

Stratified Earth.

The methods described above, in which the unknown stresses in the rupture-line do not enter into the calculations, can be used in combination with one smooth rupture-line, provided that the friction angle is constant.

When the earth consists of layers with different friction angles the method must be modified, which can be done in different way. Usually a circle is used as rupture-line, but in that case additional, more or less arbitrary assumptions must be made. Examples of such methods are the "method of the friction circle" and the "method of slices."

However, the author prefers the following method, which is simpler and requires no additional assumptions. The principle is to use a rupture-line composed of *different spirals* (or circles), each corresponding to the friction angle of the layer in question, but all having the same pole (or centre). By taking the moments about this common pole, all unknown stresses are eliminated as usual.

Fig. 4 shows, as an example, a quay, the piles of which are driven into the natural clay bottom, whereas it is backfilled with sand. The rupture-line consists of a circle in the clay and a logarithmic spiral in the sand. The latter corresponds to the friction angle φ', and in the former the shear stress c' is assumed to act, whereby the safety factor n has already been introduced. The critical rupture-line must then be found by trial as the one giving the minimum value of:

$$f = \frac{M_{G_a} + M_c}{M_{G_1} + M_P}$$

For earth masses under the water table the buoyed specific weights should be used. M_c is the moment of the shear stresses c' in the circle, and M_P is the moment of the exterior forces (such as a surcharge P and bollard pull B.).

If the minimum value of f is found to exceed 1, the actual safety factor is greater than n. Otherwise it is smaller than n.

The critical rupture-line shown in Fig. 4 goes clear under the piles of the quay. In some cases it may be necessary to investigate also rupture-lines intersecting the piles proper but going under the sheet wall. The stabilising effect of the piles (in clay) can then be found as mentioned previously.

Combating the Rat Menace

A new method of killing rats in America has made successful use of the application of " dry ice " in buildings. Dry ice is a form of carbon dioxide poison, liquified under pressure and crystallised. It gives off a 20% carbon dioxide concentration which saturates the air and kills all vermin — and any human beings nearby who are not using oxygen masks with an oxygen canister. The rats are suffocated by the gas filtering down their burrows and forcing them to the surface into the concentration. The dry ice leaves no poisonous residue on the building or its contents afterwards, and beyond the normal change of air by ventilation, no cleaning operations are required. The building is first emptied of any foodstuffs, and is sealed by closing all doors, windows and air ducting. The dry ice is broken into pieces the size of marbles, and a fan may be used for greater distribution. It takes these small pieces only ten minutes to sublimate, but larger blocks would take too long. Saturation of the air with carbon dioxide must be maintained for 12 minutes to be effective. It may also be used down burrows like any other gas.

In a special study of rat and mouse-borne typhus by the Public Health Department of the American State of Georgia, the common brown Norway or ground rat was found to make a large scale invasion of the territory of the black roof or ship rat. This has been recently studied in a six-years' trapping campaign in three counties to learn more about rat distribution; in that time, brown rats advanced by 20 miles and overran about 1,000 square miles of new territory. In some areas the two species of rat existed together in the same area for long periods of time, provided there were sufficient tall buildings for the black rats to occupy the upper storeys and the brown rats the ground floors and basements. The conquest by brown rats took place in the part of Georgia without tall buildings. The larger brown rat is able to dominate the territory and food supply of the less competitive black rat.

A study of the breeding habits of black rats was recently made at Oxford from 5,500 London dock and Cyprus country specimens. The peak breeding is in September, and from November to March is the minimum period; there is an average of just over six young per female, the number of young being in relation to the weight of the female rats. The heaviest females have the most young, but about 25% of the embryoes do not survive. Climatic differences have little effect on the breeding season (except in open country) which varies with environment and other factors, but both brown rats and black rats will breed at a peak in winter if allowed protective cover in corn-ricks, warehouse merchandise or buildings.—E.H.

Structural Timber for Dock Work

IV. Timbers for Coastal Defence Construction

By R. P. WOODS, B.A.For. (Cantab.)
Chief Scientific Officer, Timber Development Association.

"COAST erosion is a phenomenon which is continuous throughout all the seasons, and is only a facet of the cycle of world forces." This statement is made by R. R. Miniken in his admirable book "Coast Erosion and Protection," and should be remembered when viewing the events of recent months. The recent disaster has shown that the forces of Nature are so unpredictable that all the available modern materials and equipment can be set at nought when certain effects coincide and are aggravated by abnormal conditions.

The whole problem of coast protection has been receiving attention for centuries, but rarely reaches public notice unless accompanied by loss of life and damage to property. It has been tackled by Local Authorities, Catchment and River Boards, solely in the light of local conditions and requirements, to the best of their abilities, since there is no theory which can govern their deliberations. This is confirmed by the Report of the Chairman of the Hydraulics Research Board who says "Neither the characteristics of the waves nor the strength and distribution of the currents set up by given wind conditions can be calculated, and there is no theory which will allow a reliable prediction to be made of the destructive effects of breaking waves." It is the aim of the Hydraulics Research Board to overcome the deficiencies in this respect, but it will take time owing to the magnitude and complexities of the problem. Successful practice on one stretch of the coast will prove valueless in another when conditions and forces are varied by the configuration of the coast and nature of the shores, sea beds, local currents, etc. In the meantime, immediate measures must be taken to remedy the damage caused by storms and defects in the existing defences.

Many materials have been used in the protection of shores and beaches, such as stone, brick, concrete, steel, and timber. The chief forms of construction are walls, embankments, revetments, piers, jetties and groynes, and perhaps the most popular are the groynes and certainly the most familiar on many of our beaches and shores. The success of these groynes in arresting the littoral drift of shingle, etc., depends upon many factors such as height, length, orientation, etc., but for the most part timber is used for their construction. Mr. Miniken makes a very interesting statement, namely, "it is worth noting that timber withstands the assault of wave projected shingle better than reinforced concrete." The end of a concrete groyne erected at Shoreham, Sussex (Fig. 1) is shown here to illustrate this statement, although it is only fair to show wear and tear on a timber groyne (Fig. 2). One of the big features in favour of timber construction, which is not only applicable to groynes but, as has been mentioned previously, also to wharves and piers, is that any reconstruction or re-alignment can be carried out with far greater facility than with other materials.

Timbers used for Coastal Defence Work

A survey of coastal defences has shown a predilection for certain species, of which pitch pine, greenheart, elm and Douglas fir, and jarrah are the favourites. Their behaviour varies considerably with the conditions of the coast, and will be discussed later, but it must be remembered that they were erected from 20—40 years ago when there were practically no supply difficulties. The situation to-day has changed enormously, and the question of supplies must receive very careful thought when new projects are considered.

Other timbers reported as being used for piles were larch, turpentine, European whitewood, brush box, blue gum, pyinkado and redwood. Certain of these timbers are surprising, but circumstances alter cases as is well known. Walings again show a different picture in the use of species, and given in order of superiority as for piles, Douglas fir, pitch pine, elm, oak, jarrah, European whitewood and greenheart were most frequently used, followed by brush box, redwood, larch, beech, American rock elm and karri. When the sizes are discussed the reasons for some of these choices will be obvious.

Again this does not exhaust the possible timbers available for this purpose, but they may not be immediately obtainable. If, however, the importer knows of the special dimensions there is every chance that the timbers can be imported direct from the countries of origin.

Since the monetary situation is of importance, it is proposed to divide the world into the soft and hard currency areas listing timbers from each which have the reputation of being suitable for piling. The majority are hardwoods, since there are few softwoods growing in the tropics, and those that do are not suitable for this category of work. Taking the largest area, namely:—

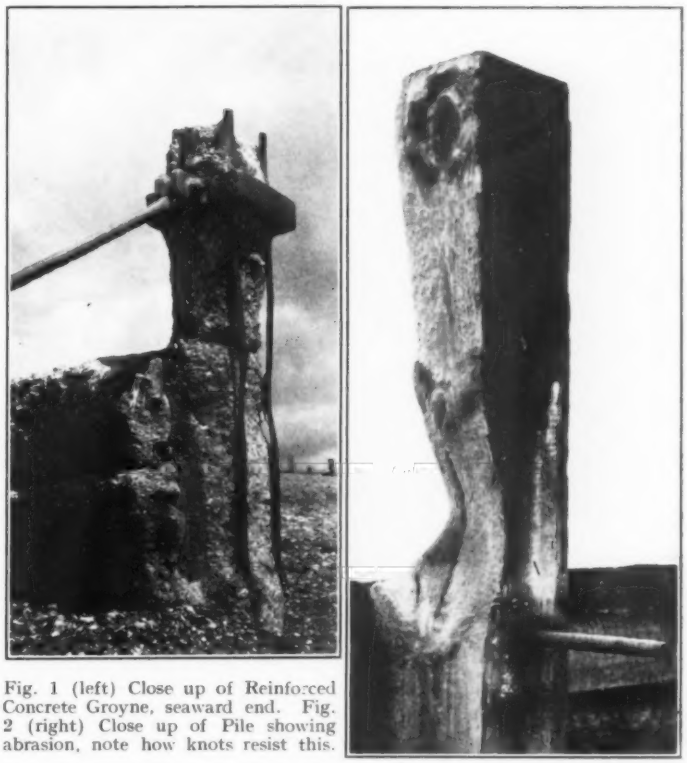


Fig. 1 (left) Close up of Reinforced Concrete Groyne, seaward end. Fig. 2 (right) Close up of Pile showing abrasion, note how knots resist this.

West Africa, the following timbers are suitable for heavy constructional purposes: ekki, afzelia, okan, niove, limbali, mukulungu, opepe and tali. Iroko has been omitted due to its greater liking for other purposes, and also for its cost.

East Africa, generally speaking, has few large trees sufficient to meet the sizes and lengths required.

Australia produces many fine timbers for piling, but internal demand is of a fairly high order, thus leaving little for export. The following timbers have all proved suitable for piles: turpentine, tallow-wood, ironbark, grey box, jarrah, yellow and white stringy bark, brush box, Southern blue gum, grey gum and satinay.

North Borneo has one timber which is fairly well known, namely belian/billian, and this is proving highly resistant to Teredo. Other timbers are listed as being suitable for piles, namely bangkwang, bangkita, bawang hutan, beus, dungun, melapi, obah, putut/pototan, resak batu and tampaluan. These are vernacular names, and it would be advisable to query the supply position with the resident Conservator of Forests.

Structural Timber for Dock Work—continued

Malaya quotes balan, chengal, giam, resak, teruntum and kandis, but providing resistance to Teredo is not required, and that abrasion is not too heavy, then keruing and also some of the heavy grade merantis could well be used.

Burma produces a highly resistant timber, namely pyinkado; thitka ingyin and pinlekanazo are also suitable for this work. Resistance to abrasion is one of the first considerations, and where decay or marine pests are present such as in wave screens, revetments, pocket sections and spur sections, then the use of pressure treated timber will minimise trouble from these sources.

South America produces the two well-known piling timbers, greenheart and angelique or basra locus, as it is also known when emanating from Dutch Guiana where the best quality grows. Other timbers are also suitable for piling purposes, etc., such as black kakeralli, determa/wane, guayacan, piquia, tatajuba and

Fig. 3. Groyne showing the heavy abrasion caused by shingle.

tauary. There are many other timbers from this part of the world but for the moment they come under the hard currency area and as such may be difficult to obtain. Pitch pine, as has been mentioned, is generally conceded to be one of the most suitable, but again the monetary condition enters into the supply question as does licensing. Honduras pitch pine, which is as strong as the long leaf pitch pine, could be a suitable substitute. The tree does not grow to a large size, but for the normal requirements of groynes, etc., it is worth considering. It is interesting to note that the supply position of greenheart has improved considerably of late.

Sizes and Specifications of Timber

As is to be expected, due to the varying conditions of the coast, there is a considerable variation in the size of timbers required, but from 50 Authorities 12 reported the size 9-in. x 9-in. x 10-ft.—18-ft., followed by nine who used 12-in. x 12-in. x 25-ft.—40-ft. Other popular sizes were 10-in. x 10-in. and 14-in. x 14-in., or 8-in. x 8-in. and 6-in. x 6-in., with lengths from 10-ft.—16-ft. Walings were 3-in. x 9-in. and 6-in. x 12-in., followed by 6-in. x 9-in. with the largest mentioned being 9-in. x 10-in. There was a wide variety of sizes ranging down to 2-in. x 7-in., and lengths showed an interesting variation 8-ft.—30-ft. with several intermediate

Fig. 4. Wavebreak on Shoreham Beach. Softwood timbers should be pressure treated with a preservative in such situations.

lengths also being recorded. The requirements for a 255-ft. long groyne which will indicate the sizes and quantity of timber needed are as follows: 52 piles 9-in. x 9-in. x 10-ft.—14-ft.; 280-ft. run of 6-in. x 9-in. walings 17-ft. and up; 1300-ft. run of 3-in. x 9-in. planking in 15-ft. and 20-ft. lengths. Whilst this specification may not be applicable for every coast, it is fairly exacting as regards to lengths; and results in either increased costs or, alternatively, difficulty in obtaining supplies.

Whilst it is true to say that timber is an inexhaustible crop, thought must be given to the fact that it takes time to grow, and when one considers that those favoured timbers were from 100—200 years old at the time of felling, sufficient time has not elapsed for the young crop coming up to reach the same maturity. Heavy cutting of the old trees has reduced the amount of large sizes available, and has resulted in a search for alternative timbers.

The above statement must be remembered when it comes to ordering new timbers, and specifications which were suitable in those days could well be revised in the light of the supply situation to-day. The writer has recently seen a specification which called for 9-in. x 9-in. English oak *free from sap*. The recent war period has resulted in heavy cutting of our woodlands, and to meet a specification of this nature would require very careful selection and much searching. Another point to remember is that there is always a big demand for prime quality English oak in the joinery and furniture world and such timber commands a high price. What are the objections to sap in the construction of groynes? We know that it is weaker, more prone to decay and abrasion, but if the piles or walings are oriented in such a manner that the heart face is exposed to the greatest wear, and that the amount of sap is limited to say one face, or two corners, then it opens up a wider range of material to supply this market. Another point is "freedom from knots"—this is not consistently specified, but there are still many to-day who specify such. Obervation will show how knots resist abrasion, and will stand out proud of the eroded areas (see Fig. 2) so that the inclusion of such material, i.e. lowering the grade, should be taken into consideration.

This must not be considered as an attempt to lower the strength standards of such all important structures as groynes and other sea

Fig. 5. New West Works, just south of the Dunes at Littlehampton, Sussex. Section F 2 and up to the 13th Greenheart King pile in Section G, showing Greenheart hewn rakers and gangway.

Structural Timber for Dock Work—continued

defence works, but is an attempt to explain the difficulties which are faced by merchants who have to try and meet an order based on such rules, from material which is practically unobtainable in certain timbers.

Methods of Preservation

The application of a preservative, under pressure, is to be strongly recommended for all timbers with a low degree of natural durability, for situations where they will be subjected to marine borer attack or fungal decay. Such positions are the seaward ends of groynes, the landward ends, revetments, piers, jetties, wave breaks, etc., but it is doubtful if any benefits will accrue where scour is of a high order. As can be seen from the photograph (Fig. 3) heavy shingle wears away the timber at an alarming rate, and unless 100 per cent. penetration, which is only achieved with certain timbers, can be guaranteed, the mechanical life of the wood is of such short duration that the expense is not justified. In addition with timbers such as Douglas fir, pitch pine, redwood, etc., preservative penetration will only be found satisfactory where sapwood is present, and it has limited penetration into the heartwood. The experiments initiated by the Timber Development Association have shown that *Teredo* appear to have a fairly high toleration of pollution, that is if the concentration of the preservative has deteriorated due to leaching, attack slowly commences. *Limnoria*, which is more prevalent than *Teredo* in the waters around the coast, shows similar resistance. In this respect the presence of bark appears to be worthy of consideration as a protection against this pest. Evidence is available to confirm this point. On the choice of preservative the British Wood Preserving Association should be consulted.

Specifications requiring large sizes and long lengths limit the selection of timbers obtainable, but from the data available, and if consideration is given to the possible lowering of the grade, there should be little difficulty in meeting the requirements for sea defences. The disadvantages of timber are more than outweighed by the advantages, as have been mentioned.

Correspondence

To the Editor of *The Dock and Harbour Authority*.

Dear Sir,

Meteorological Surges in the North Sea

With reference to the valuable editorial on sea defence and floods in the February issue of your journal, I think most practical Conservancy Officers and Engineers must endorse your suggestion that the sea defence of the sea coasts of Great Britain must necessarily be organised and financed on a national basis. The co-ordination of meteorological and tidal research should surely be a first priority.

Surely a central " Tide-Met." bureau should be inaugurated and made responsible for co-ordinating the various branches of science and research covering this field, and also for giving intimate executive direction and authoritative advice. In view of the present advances in our knowledge of the mechanism of meteorological surges and the ability to predict them, given the meteorological data, particularly in the North Sea area, it is remarkable that such vital matters should still be left to the judgment of various loosely connected groups without the advantage of a clear over-all picture of the situation. The remarkable resource shown by these groups in the recent floods is indeed worthy of more accurately co-ordinated intelligence.

It is very clear that the valuable researches of the Liverpool Tidal Institute have since 1828, in several valuable papers, revealed the fundamental cause of phenomenal North Sea surges. and the admirable summary in the Admiralty Tide Tables for 1953, Preface, Page VIII, gives an excellent practical summary of our knowledge. They are apparently caused by a synchronous response of the 36 hour " stationary wave " period for the North Sea to alternating southerly and northerly winds, produced by marked low pressure systems, moving East-South-Eastward at a certain speed from a position well North-West off the Irish coasts.

The southerly wind ahead of the depression maintaining its direction and force over an approximately 18 hour period drives surface water out of the North Sea (roughly as the square of the velocity). Subsequently, the northerly wind ensuing in the rear of the depression, and increasing in velocity, builds up levels towards Dover in the remaining 18 hours, thus completing the natural period of response for the North Sea, which as stated is approximately 36 hours. If such a stationary oscillation is imposed upon, and synchronises with, the times of local High Water, the total build-up can produce the tragic results recently observed. Whilst the Liverpool Tidal Institute, and other interested scientific bodies, have now at their disposal means for deducing probable heights of surges from a very close observation of absolutely up-to-date synoptic isobaric charts, it is clear that there may be many other related phenomena which can be determined only by empirical methods. It is surely, therefore, imperative that the nation should assist the Liverpool Tidal Institute, or any others charged with collaborating in researches, towards the end we are considering, by establishing, without delay, widely scattered and representative tide gauges over the whole North Sea coastal area, with modern means for the immediate and continuous communication of accurate readings to such a central " Tide-Met." bureau with responsibilities such as I have indicated above. This is well within the resources of modern telecommunication devices and methods.

Whatever may be the electronic methods for mathematical summation and prediction now in employment, or under consideration, it is certain that the premises, or arguments, upon which such computations may be based, must at this stage be inadequate to cover all the variables involved in nature. Is it not, therefore, most essential that the readings of such widely scattered, suitably sited, and instantly available, tide gauges as I have mentioned should be provided for the detailed and systematic correction and supplementing of the main predictions? If this is a true estimate of the facts and requirements, clearly no cost should be spared in providing this facility as soon as possible, even in the interests of further research.

When all this has been done it would also appear that apart from the application of this intelligence to planning emergency engineering works at vulnerable coastal areas to protect property and land, there is a further requirement for the anticipation by such means of rescue precautions, specified at several degrees of readiness, which should, ideally, be organised at high levels, and in a unified manner, possibily by the Services, for the saving of life by accurate and local warning systems, the prior dropping of buoyant devices, and disposition of amphibious craft.

We may well hope that such a phenomenal surge as we have recently seen in the North Sea may not occur again perhaps for centuries, but the application of the fruits of scientific research, and our increase in knowledge, cannot be disregarded by any civilised community.

It is accordingly to be hoped, and expected, that the financing of British tidal research, and the provision of devices for the accurate field measurements of related hydraulic data for their analyses and prognosis, should be given the priority with which the recent tragic events have surely invested them.

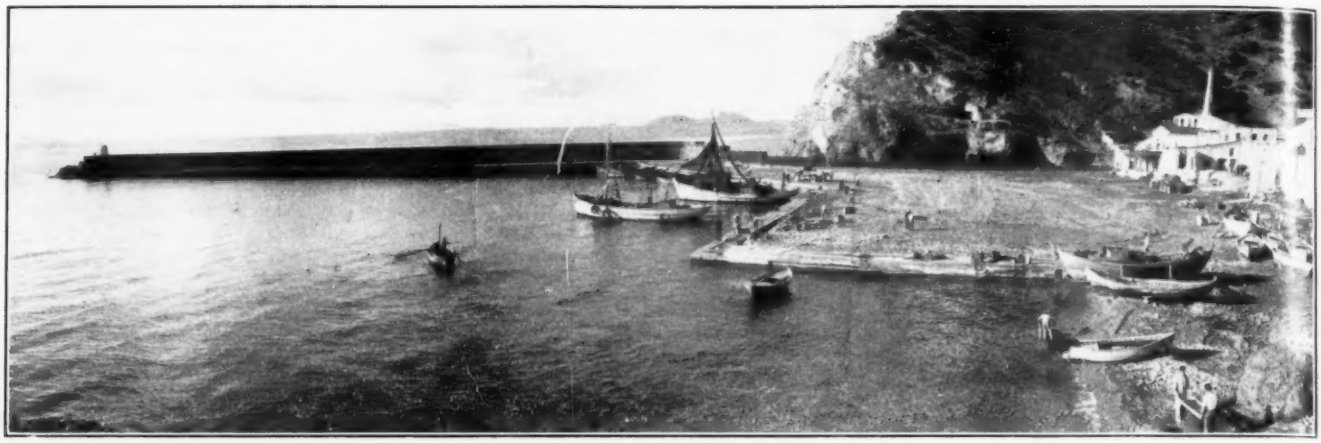
It would appear that the establishment of such a bureau as I have suggested would be valuable for extending the researches to the English Channel areas, and elsewhere to the end that the increment of meteorological perturbation should be given daily and thus not take any Authority by surprise.

Yours faithfully,

Hydrographic Department,
Southampton Harbour Board. D. H. MACMILLAN,
6th March, 1953. Commander, R.N.R.

Proposed Improvements at the Port of Tanga.

The East African Railways and Harbours have announced plans to develop the port of Tanga. A new lighterage quay, 700-ft. in length, is to be built, and, on completion, the existing lighterage quay is to be reconstructed by providing a new wharf wall. The new 700-ft. quay will be equipped with one 20-ton and six 5-ton cranes, and the reconstructed wharf will also be re-equipped. Work is scheduled to commence this year, and it is estimated that the whole project will be completed by the middle of 1955, when the port will be capable of handling up to 700,000 tons of cargo per annum, compared with the present capacity of 260,000 tons of cargo.



View of completed mole, or breakwater, and quay walls, St. Galini Harbour.

Port of St. Galini

A New Harbour on the Southern Coast of Crete

By C. CONSTANTINOU, Civil Engineer, General Director of "Archimidis" Contracting Company, Athens.

THE largest island of Greece, the island of Crete, is located in the middle of the Eastern Mediterranean, halfway between the Greek mainland and North Africa, and until recently, it had no harbour on its Southern coast.

The Hellenic Government, convinced of the necessity of constructing a harbour on this coast, in common with the representatives in Greece of the Mutual Security Agency, decided to build a harbour at the western end of the Messara plain, the large central plain of Crete, near the village of Aghia Galini which is connected to the largest city of the island—Heracleion, with a regular highway, about 80 kilometres long.

The fact that such a harbour had not previously been constructed was obviously due to the high cost involved by the technical difficulties which are met with on the southern coast of the island, which faces the open sea and is subject to continuous heavy wave action during almost all the seasons of the year. Even during the four months of summer when the northern winds are prevailing, an extremely annoying pattern of reverse oscillatory waves is prevalent, which hinders construction operations and is dangerous to the necessary construction floating plant.

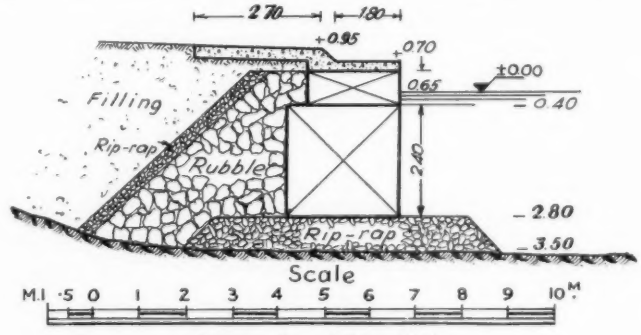
The above reasons explain the fact that after a contract for the construction of this harbour had been awarded to a contracting company, the contractor executed only a certain number of precast blocks on the ground before work was discontinued and the contract later dissolved.

On account of the importance of the job, the Greek Authorities decided to let another contract for the work, with construction commencing in May, 1952, and fixed as the time-limit 122 days, in order to take full advantage of the summer four-month period which provides relatively the best weather and sea conditions. The main object of the work was the construction of 145 metres of breakwater, and quay walls of a total length of 130 metres as well as of certain secondary works, among which was the construction of protection work and the diversion, north-east of the breakwater, of a torrent that used to have its outlet in the middle of the site of the proposed quaywalls.

The problem to be faced was first to secure the necessary floating plant for completing the job within the time-limit, and second to provide some security for these floating craft, as the configuration of the coast could offer no shelter for that purpose. Such security was indispensable because the precast blocks built by the previous contractor had to be hauled by sea through a shallow section where the reverse oscillatory waves provoked by the northern winds was likely to cause extremely difficult conditions for these operations. The "Archimidis" Contracting Co., to whom the contract was finally awarded, believed that under the specified conditions contract could not be performed. The only economic way of securing the safety of the floating equipment would be to use one or two caissons and to sink them along the line of the breakwater on a length of 50—60 meters, which would be speedily filled with stone in order to provide an immediate protection block, behind which the floating craft could shelter.

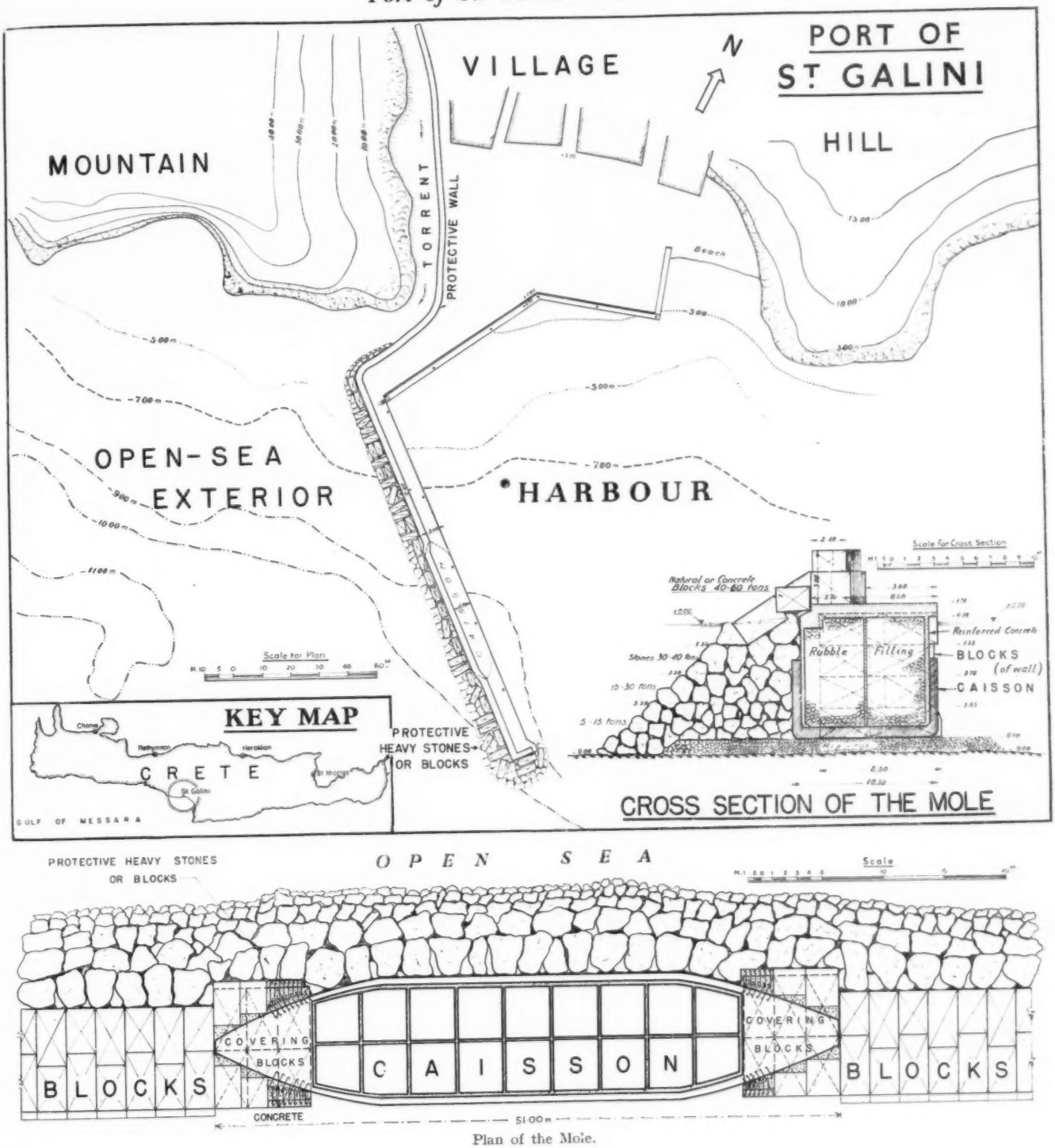
The time-limit set, however, gave no possibility of such a solution. In trying to find a means within the time-limit set, "Archimidis" Contracting Co. discovered an old concrete ship built in Great Britain in 1919 which was lying on a Greek coast, the form and dimensions of which would fit the purpose if some shaping and reinforcing with transverse walls and raising in height took place. The strengthening walls would have to be in reinforced concrete and the raising would be at least 2.80 metres in order to allow the necessary general depth of 8.30 metres. On account of the length of this ship (51 metres), it was necessary to avoid an uneven settlement of the foundation ground, the latter was checked by the contractor who ascertained that the ground was a sound conglomerate along the whole length of the breakwater. The fact that this "caisson" would be founded at a depth of 9—10 metres and that a very heavy protection with concrete blocks or natural breakwater stone would be added seawards, rendered this solution still more attractive.

The Greek engineers at the head of a special Service of the Ministry of Public Works, as well as the American engineers at the head



Cross-section of Quay Wall.

Port of St. Galini—continued



Plan of the Mole.

of the M.S.A. Construction Division, examined and adjudicated the contractors' proposals which were submitted, and investigated the matter thoroughly by going to the site. They finally approved the solution in question, awarding the contract to the "Archimidis" Contracting Co. for the sum of £135,000, in which was included the purchase price of the concrete ship.

The contractor was installed on June 1st, 1952, and immediately started the construction, levelling and preparation of the submerged rip-rap base on which the "caisson" would be founded. Simultaneously, the concrete ship was transformed and reinforced and raised in Piraeus harbour on the basis of plans prepared hurriedly under the directions of the Chief of Operations of the Service, Mr. Mentzelopoulos, and by Engineer Mr. M. Papadakis. This work was sublet to the N. Gavalas Contracting Company, and completed within three weeks.

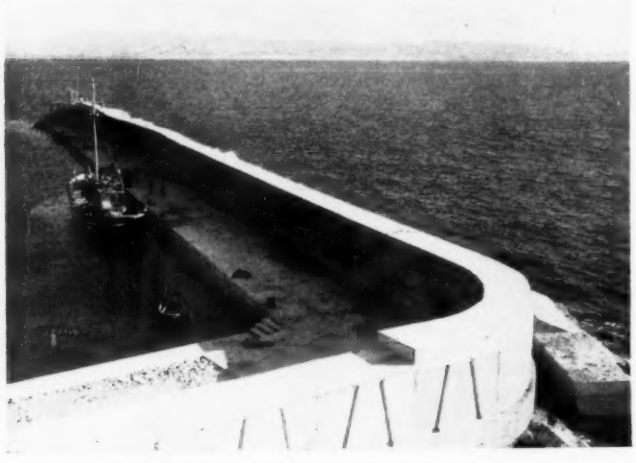
The concrete ship thus transformed into a caisson was towed from Piraeus to St. Galini within three days. It had been divided into 18 separate compartments and a number of valves were provided at the bottom. Special care was taken to have these valves operated from the top of the caisson. Another set of valves allowed communication between the compartments. Through adequate manipulation of these valves, it was possible to sink the ship at the

Port of St. Galini—continued

The Caisson-Ship being manœuvred into position at site.

View of Caisson-Ship a few minutes after sinking.

Placing blocks or the sunken Caisson-Ship.



Close-up view of completed Breakwater.

proper spot. The caisson ship was held in place by four anchors at 70 metres each from the ship, and the anchorage was tightened by four winches through the operation of which the ship could be moved. In addition to the anchorage, a 450 h.p. tugboat and a self-moving floating crane were standing by. In spite of all these precautions, the strong winds and the constant heavy wave action moved the ship during the sinking operation, and 30 hours elapsed before weather conditions allowed the holding of the vessel on the proper spot, so that its sinking along the line could be accomplished. Sinking operations occupied three hours. As it was not certain that during these three hours weather conditions would not be changed, provision had been made for closing the outer valves and pumping the water from the ship to the extent when its removal and bringing back to the proper spot could be effected. Very happily this was not required.

For the sake of a speedy filling of the compartments with stone, provision had been made for using a self-propelled lighter which would receive four full-loaded trucks at the shore and transport them to the ship for direct unloading. Unhappily, the prevailing wave action during these days did not allow such operation and an unloading ramp had to be built in a few hours on the shore in order to allow the direct dumping of the stone from the trucks into the lighter as well as into the scows hurriedly fitted for the purpose. The unloading of the stone had to be done by hand. Work was organised in three shifts and 3,000 cubic metres of stone was transported and placed in the caisson ship within 12 days.

After the sinking of the caisson ship which provided an immediate safety area, the large floating plant, indispensable to the job were brought to the site. Among these were two large floating cranes, one of which was used for dredging an approach channel to the blockyard for facilitating the reaching of the blocks and their subsequent transportation to the spot of utilisation. These blocks were set on either side of the caisson ship as shown on the accompanying plan.

Great difficulty was encountered in transporting about 10,000 cubic metres of natural breakwater stone (the average weight of each reaching 60 tons), which was placed seawards of the breakwater together with about 2,000 cubic metres of precast blocks, as a protection. This natural breakwater stone had to be picked up from a distance of $2\frac{1}{2}$—$3\frac{1}{2}$ miles, west of St. Galini. In order to render this possible on an unprotected coast, it was very often necessary to clean up the bottom, along the approach to the coast, removing submerged rocks which either had to be lifted by the cranes or blasted. In spite of these difficulties, preference was given to a wider use of natural breakwater stone instead of concrete precast blocks, because of the better interlocking and therefore of a more compact seaward protection.

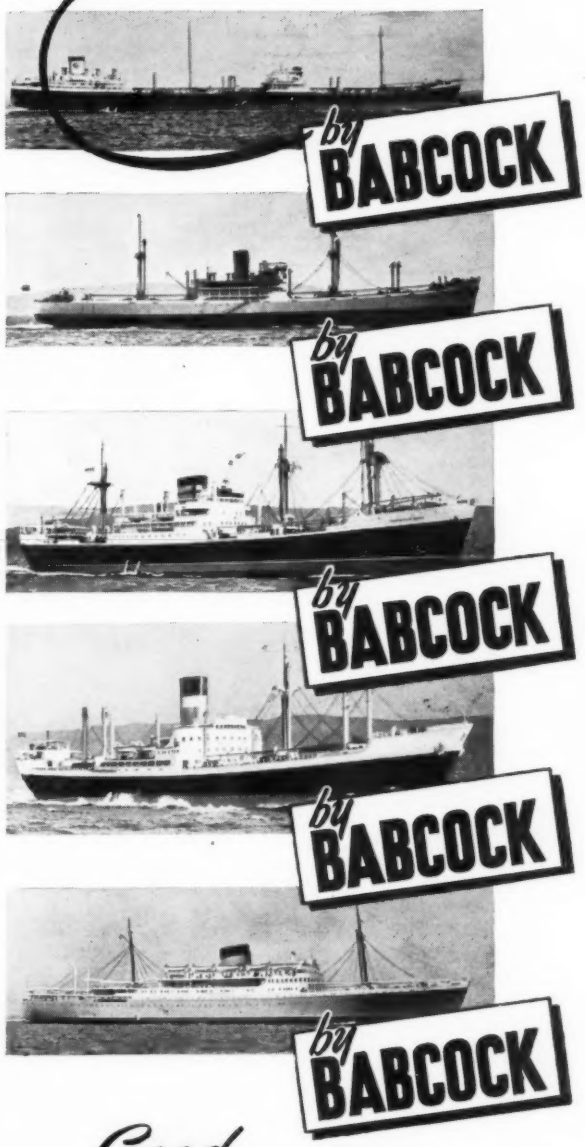
The whole work was completed within the time-limit set, with only a small delay of 23 days (due to increased work ordered by the Service over and above the initial estimate), i.e. the work was completed in 145 days. Eleven days after its completion, the breakwater was subjected to its first trial as a severe storm attacked the area. It resisted successfully and no damage was ascertained. It is, of course, possible that due to the fact that no time was allowed for the natural setting of the rip-rap, that some fissures or settlements will develop, as this usually happens. In this event, matters can best be taken care of after the winter storms have been experienced with the most extensive beating with waves, which may be expected to reach a height of five metres.

It may be interesting to state that besides one 65 ton floating crane owned by the Hellenic State, the following equipment belonging to the contracting company was used:—

(a) One revolving 40-ton floating crane, capable of operating a five cubic yard clamshell grab.
(b) One self-propelled lighter equipped with a 10-ton crane.
(c) Two self-propelled dump-scows of 120 tons each.
(d) One 400-ton scow.
(e) Two tug-boats of 450 h.p. and 120 h.p.
(f) Several small motor-boats, diving equipment and row-boats.

The construction of this harbour within so short a time-limit illustrates the fact that Greece has to-day both human and mechanical equipment with which important projects can be perfectly handled and brought to a satisfactory conclusion.

Boilered



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The Railways and Ports of Southern Africa

A Review of the Present Position of Transport

(Specially Contributed)

Foreword.

BECAUSE the free flow of rail traffic from the Union of South Africa to destinations in Southern Rhodesia and other northern territories has at times been severely restricted by the inadequacy of existing railway links, it was decided by the South African Railways to devote a special edition (September, 1952) of "Railway News," the official publication of the South African Railway Administration, to the difficulties associated with the handling of traffic for northern destinations from Union ports and other South African centres.

Readers of "The Dock and Harbour Authority" will remember the subject of transportation in Central and Southern Africa has already been dealt with in past issues; in particular might be mentioned the article by Brigadier G. S. Brunskill, C.B.E., M.C., in July, 1949. In this, the desirability of not only considering railways but roads and navigable waterways was stressed. Likewise, in August, 1950, an article on "The Ports of Mozambique" contained some interesting comments on the significance of the Ports of Lourenco Marques, Beira and Nacala and the possibilities of their railway communications in connection with the future development of the countries comprising their hinterlands.

The following is a review of the present position of transport in Southern Africa, based to some extent upon the special edition of "Railway News" referred to above, and also upon data obtained from other sources of information. It must be remembered that, at the present time, Railways, Airways and Harbours in the Union of South Africa are administered under one centralised control.

Overloading of the Railway to the North.

The publicity given in recent months to unusual congestion at Port Elizabeth Harbour, and latterly at Durban, and to the difficulties experienced by the South African Railways in clearing the traffic for Southern Rhodesia and destinations to the north over the railway system of the Union, has once again drawn attention to one of the biggest bottle-necks of the railway system of Southern Africa, the Mafeking-Bulawayo line. These difficulties have been seized upon in certain quarters to level unwarranted criticism at the South African Railways, both in South Africa and Rhodesia, coupled with a demand for unrestricted road transport. There appears, therefore, to be an urgent need for authoritative information on the general subject of railway links between the Union of South Africa and its northern neighbours.

Some statements recently made by the Minister of Mines and Transport for Southern Rhodesia indicate that, while the Rhodesian Railway Authorities felt that the Mafeking-Bulawayo line could carry more traffic, it would not be adequate for all the Rhodesian import traffic of the future, and consequently they had repeatedly asked for the capacity of the line to be increased. Also, it was contended that the S.A.R. had not developed the water resources of the line.

Dealing with these points, the report says: "What are the facts? The railway line Vryburg-Mafeking-Bulawayo belongs to the Rhodesia Railways, but is operated by the South African Railways under agreement. One of the provisions of the contract is that Rhodesia Railways must provide the locomotive power necessary for the clearance of the traffic over the section mentioned. Sufficient locomotive power has at no time been provided by the Rhodesia Railways, but by employing South African Railways' equipment and applying South African operating technique it has been possible to transport successive increases in traffic which has been offering, as shown below:—

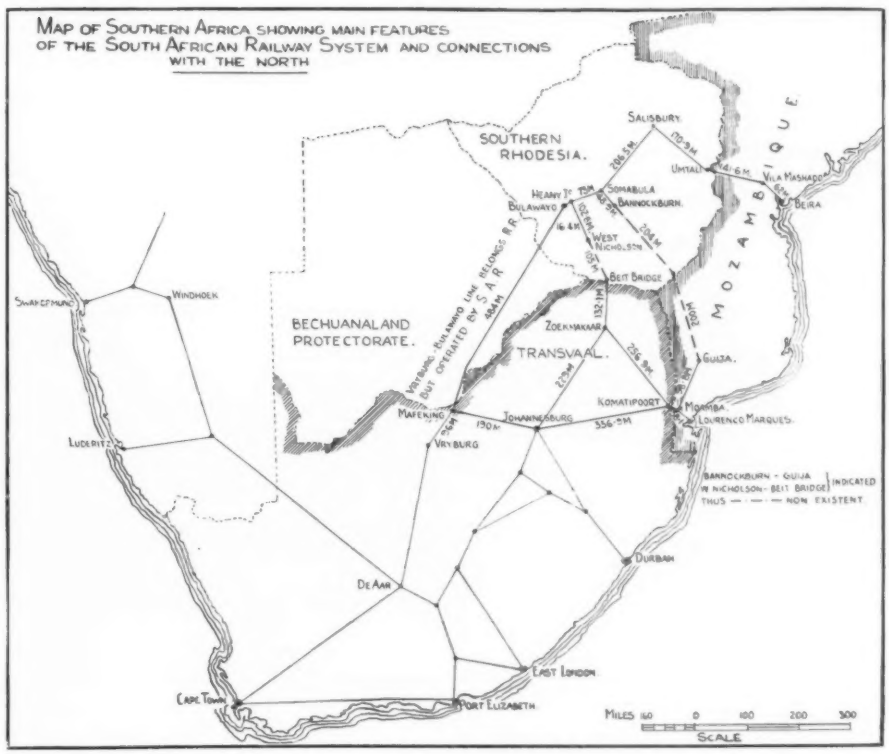
Year ended March 31st:	Tons.
1948	220,946
1949	390,787
1950	491,022
1951	643,141
1952	704,275

The tonnages quoted are clearances north from Mafeking.

"Traffic on the section Vryburg-Mafeking has at no stage had to be restricted on account of deficiency of water supplies, or, as a matter of fact, for any other reason, and this aspect of the question does not therefore arise. The combined traffic from the south direction, Vryburg-Mafeking, plus that from the Reef and other places of origin via Zeerust, has reached dimensions where not only a deficiency in locomotive power but also a deficiency in available water supplies have necessitated restrictive measures being adopted from time to time. Since the end of 1950, by arrangement, 26 boreholes have been sunk on the Mafeking-Bulawayo section, eleven of which have proved suitable for exploitation, and all have been equipped, but three are giving trouble, which are engaging attention. . . .

"Because of the deficiency of suitable water supplies at strategic points for engine-watering purposes during certain times of the year, tank wagons have to be attached to the locomotives, displacing ordinary traffic, and on occasions whole water trains have to be run to convey water to suitable points for locomotive purposes. This, too, displaces ordinary traffic.

"It should be remembered that there is no machinery whereby discharges of cargo at Union ports, destined to the Rhodesias and Northern territories, can be regulated, and this free inflow has at times caused heavy



Railways and Ports of Southern Africa—continued

accumulations at Union ports on account of the inability of the only line available, i.e. Mafeking-Bulawayo, being unable, because of the factors already mentioned, to carry the traffic that is offering. . . ."

It is reported that the Minister of Transport of Southern Rhodesia has stated that the construction of the line from Bannockburn to Guija and thence to Lourenco Marques in Mozambique was of first priority. This port was the natural outlet for the Transvaal, Swaziland and Southern Rhodesia and was the main port of Portuguese East Africa. The Minister also said that Southern Rhodesia would continue, however, to press for an improvement of the Mafeking-Bulawayo line. This, it should be noted, was in spite of the fact that the increase in traffic conveyed over that line had practically trebled since 1948.

There appears to be, in some quarters, an opinion that the S.A. Railways should relax the monopoly on transport, while the present congestion lasts, by allowing firms to use their own lorries to transport their own goods. By so doing, it was argued, more trucks and engines would be released for carrying freight.

The S.A. Railways, however, in reply to this suggestion, pointed out that the difficulty they had to contend with was not a shortage of rolling stock, but that the section of the line from Mafeking to Bulawayo could take only a maximum of nine trains per day in each direction. Moreover, it was reiterated that S.A. Railways had, at all times, indicated their readiness to transport more goods to the Beit Bridge railhead for conveyance north by road, but that the authorities in Rhodesia had indicated that they could not allow unlimited quantities of goods to go by road from Beit Bridge to destinations in Rhodesia.

These arguments, however, do not appear to have silenced the critics. Although admitting that it was partly through the existing inadequacies of the Rhodesia Railways that goods were accumulating at the ports, their plea is for the alleviation of the disadvantages suffered through rail congestion, by an increase in road transport, despite any temporary financial loss that the S.A. Railways might suffer.

The Existing Railway System of Southern Africa.

The accompanying map shows the main railway network of the South African Railways and the connections with the north, together with distances between important points. The line from Mafeking to Bulawayo belongs to the Southern Rhodesia Railways, but under agreement is worked by the South African Railways. The line running northwards from Johannesburg to the Limpopo terminates at Messina (Beit Bridge), on the border of the Union of South Africa and Southern Rhodesia.

Port Elizabeth has become the traditional South African port for import traffic consigned to Southern Rhodesia and other northern destinations, but all Union ports share in this traffic to some extent. It will be noticed that the railway line from Port Elizabeth is a fairly direct one via De Aar and Mafeking to Bulawayo, and that an equally direct line would be provided via Naauwupoort, Bloemfontein, Johannesburg and Beit Bridge, provided the section was completed from the latter point to West Nicholson. Messina, at Beit Bridge, is already an important railhead and some goods are now despatched north by road from this point.

Varied assortment of goods awaiting transport at Cape Town Harbour.

The strategic positions of the Ports of Beira and Lourenco Marques should be noted and also their railway connections, which form important access links with the Rhodesias.

The Case for an Alternative Railway Route.

The Report goes on to say: " The South African Railways Administration has on many occasions in the past, stressed the need for providing an alternative rail route to the north and for taking all possible steps to increase the capacity of the Mafeking-Bulawayo line, which is a single track and has certain disadvantages such as comparatively small and variable water supplies."

The restrictions imposed on the volume of traffic interchanged by inadequate terminal facilities have been improved. Likewise an improvement has been effected by the provision of additional locomotives.

" The position has, however, been reached where the available water supplies will not allow of any further increase in the train service. . . . This shortage of water can be ascribed partly to drought conditions, but the view is held that the continued drain on existing sources has been in excess of the natural supply, which has resulted in a failure of some sources and diminishing supply in the case of others. Surveys to provide additional water supplies have been far from encouraging. . . ."

" Whilst it is not contended that an improvement of the water position on the Mafeking-Bulawayo section is impracticable, it is definitely the opinion of the S.A.R. that it can only be brought about on a long-term basis and then only to a limited extent. Over the 489 miles section, the line traverses a semi-arid country with limited natural water resources "

With regard to alternative methods of locomotion, the use of which would be, obviously, a solution of the water problem, the report states: " Alternative methods of locomotion have been considered and the mission of railway experts sent overseas to study transport conditions in Europe, Canada, the United States, as well as in the Argentine and Brazil, came to the definite conclusion that dieselisation is not a practicable proposition in South Africa due to the fact that diesel traction is vastly more expensive than steam, for fuel for the operation of diesel locomotives would have to be imported, whereas vast supplies of cheap coal are available locally for steam operation. In so far as South Africa is concerned, rail diesel traction is therefore considered quite uneconomical. It is true that by the use of steam locomotives with condensing tenders, it may be possible to mitigate the difficulties connected with water shortage, but not much hope can be held out that relief in the direction indicated will be forthcoming in respect of the working of traffic between Mafeking and Bulawayo, for some time to come. There would, therefore, seem to be only one alternative to give relatively early relief and that is to seek another outlet for traffic emanating from and passing through the Union of South Africa for the Rhodesias."

Quoting figures indicating the growth of through traffic from the Union of South Africa to Bulawayo and beyond, conveyed over the Mafeking-Bulawayo rail route, from 1943 to 1952, the Report continues: " An analysis of this traffic shows that of the total of 704,275 tons conveyed during the year ended March 31st, 1952, 488,487 tons emanated from inland stations in the Union; 84,614 tons from the port towns and 131,174 tons ex ships. It will be seen that of the

Railways and Ports of Southern Africa—continued

total traffic conveyed by rail, only 19 per cent. was seaborne or imported. Of the total tonnage of traffic received at Bulawayo from south, 135,391 tons represent goods railed from Port Elizabeth.

"The import traffic for the Rhodesias passing through Union ports may be regarded as traditional and has continued to flow through Union harbours for many years, despite the considerable rating advantages in favour of the port of Beira, which have persisted for many years.

"Beira is regarded as the natural port for South-Eastern Rhodesia, and there is no doubt that the vast bulk of import traffic for that region will continue to be dealt with at that port, which is more favourably stituated than Union ports in relation to the Rhodesias.

"A glance at the map of Southern Africa will show that a small gap of 105 miles between Beit Bridge and West Nicholson has to be linked up to provide that alternative route, which between Johannesburg and Bulawayo will be 50 miles shorter than via Mafeking. The closing of this gap has been visualised for many years by such a body as the Beit Trust which, at their own expense, built the Beit Bridge over the Limpopo as a first instalment as far back as 1928-29."

The volume of traffic that would be diverted from the Mafeking-Bulawayo line if this gap were closed is a question of some importance. Firstly, it may be assumed that traffic would be transported over the route which is geographically more advantageous. In this respect the Mafeking route is more advantageous to Cape Town and Port Elizabeth; also to East London although by only a few miles. On the other hand, the Beit Bridge route is more favourable to Durban, Lourenco Marques, Johannesburg and the Orange Free State.

The S.A.R. are satisfied that the approach lines to the Beit Bridge-West Nicholson route would be capable of carrying the traffic that would be diverted to them, and the report sets out the advantages of the new route.

Summary of Advantages.

"The advantages of the bridging of the gap between Beit Bridge and West Nicholson can be summarised as under:—

(1) The only major item of capital expenditure that would be required is that for the construction of the new line between Beit Bridge and West Nicholson.
(2) The distance between Johannesburg and Bulawayo would be reduced by 50 miles.
(3) The port of Lourenco Marques would become available to both Southern and Northern Rhodesia, the distance being three miles less between Lourenco Marques and Bulawayo via Beit Bridge as compared with Bulawayo and Beira.
(4) Any diversion of traffic from Beira to Lourenco Marques for Bulawayo and environs and Northern Rhodesia would bring relief not only to the port of Beira, but would also relieve the section of the line east of Bulawayo.
(5) It would relieve the seriously congested Mafeking-Bulawayo line and provide a free exchange of traffic from the Union and Union ports to Bulawayo and environs and Northern Rhodesia.
(6) It would be the quickest means of providing the urgently needed relief on the Mafeking-Bulawayo line.
(7) For some time to come there will be no need for capital expenditure in connection with improvements on the Komatipoort-Zoekmakaar section.

Support for Beit Bridge Connection.

"The urgency of another rail link between the Union of South Africa and Southern Rhodesia to supplement the present single track between Mafeking and Bulawayo has been publicly admitted from time to time by transportation experts, by railway representatives and by commerce and industry. The accumulation of traffic for Southern Rhodesia and other northern territories at the harbour of Port Elizabeth and, to a lesser extent, at East London and Durban, is a direct result of the inadequacy of the existing rail outlets from Southern Rhodesia to the Indian Ocean, viz. the Mafeking-Bulawayo line and the Beira-Salisbury route via Umtali. . . ."

In this respect the closing of the Beit Bridge gap would afford alternative routes to Southern Rhodesia from Port Elizabeth, East London, Durban and Lourenco Marques. Thus the inference must be that congestion at those ports would be relieved.

The Report continues with a statement contributed recently to "Optima," a quarterly review published in Johannesburg, by Mr. Marshall Clark, who was formerly General Manager of the S.A.R. and at one time Secretary-General of the Central and Southern Africa Transport Organisation. His statement reads: "It is consideration of its own railway revenue that has caused Southern Rhodesia to embark on the construction of a new railway to Lourenco Marques, instead of building a link—a quarter of the length—between West Nicholson and Beit Bridge." He also compares the motives governing the construction of the former, i.e. to avoid the Transvaal, with those which actuated Cecil Rhodes 50 years ago, when he built the Mafekin-Bulawayo line to avoid the Transvaal Republic.

The statement also mentions the efforts to establish, some three years ago, an International Transport Organisation for Africa south of the Sahara, and the good work done in the technical field in respect to agreement concerning an international road development plan. He deplores the fact that the effort has now, however, degenerated into nothing but a series of disconnected conferences, and says, "Surely, if international co-operation is possible in any field, it should be so in the matter of transport, which with the political geography of Central Africa as it is, must be an international matter."

Mr. Clark advocates the establishment of a strong and permanent international organisation, to co-ordinate existing and future transport facilities. Such an organisation should undoubtedly have wide terms of reference and be free to consider economic problems uninfluenced by political considerations. For such an organisation to be successful in attaining the object of developing the transport and ports of Southern Africa internationally, however, it is apparent that it must be able to sponsor full and frank discussions of all problems.

As regards the present port and harbour facilities, it is stated in respect of Port Eliza-

Accumulation of goods off-loaded from ships at Port Elizabeth and awaiting clearance by rail to northern destinations.

Railways and Ports of Southern Africa—continued

beth that they are equal to handling the present large tonnages, which are six times the tonnage which entered the port six years ago, and that congestion is due entirely to the inadequacy of the Mafeking-Bulawayo line. It is also pointed out that as a result of delays to shipping at Beira, cargoes destined for Rhodesia were diverted from that port for discharge at Union ports.

The Report goes on to mention the various ways in which congestion and transport problems had been, to some extent, alleviated by the two railways, for example, new shed accommodation outside the docks, allocation of truckage according to priority of goods, restriction of movement of certain commodities, the routing via Beit Bridge of motor vehicles from South African ports for Northern Rhodesia.

Views of Rhodesian Railway Users.

Users of the Rhodesian Railway were much concerned that, owing to shed congestion at the ports, the S.A.R. might re-impose special storage and handling charges for which they had legal authority. Alternatively, that they might remove goods from Port Elizabeth and dump them in the open at Mafeking.

The Report quotes an address to the Rhodesian National Affairs Association at Bulawayo given in September, 1951, by Sir Arthur Griffin, General Manager of the Rhodesian Railways. This sums up the view of the Rhodesian authorities upon the closing of the Beit Bridge-West Nicholson gap, and, judging from the reported speech, appears to be governed entirely by the economics of the traffic situation which would arise if this length of line were built. The effect would be to divert some overseas imports from the Mafeking line to Beit Bridge connection and the more serious diversion to the new line of Union traffic from its great industrial areas. The loss of revenue (i.e. to the Rhodesia Railways) was estimated at three-quarters of a million pounds per annum, which would accrue to the S.A.R.

That benefit to transport and trade generally would be gained by completing the Beit Bridge link in communications can hardly be doubted, notwithstanding the possibility that other lines of railway may also be needed. A glance at the map indicates how logical is the proposal geographically, and it surely is within the compass and ingenuity of the two railways and countries concerned to evolve a working agreement in respect of running charges, division of revenues and so on.

Other Suggested Ports and Railways.

In regard to other links in the chains of transportation in Southern Africa, the necessity of additional ports has been brought forward from time to time. For example, to serve the Rhodesias, repeated references have been made in the past to a new port at Tiger Bay on the west coast. However, it now appears to be recognised that the logical ports for the Rhodesias are on the east coast for, as we have seen, prominence has been given to the rail link schemes aimed at Beira and Lourenco Marques, while further

Heavy loads being handled at the Port of Durban.

north, the new port of Nacala offers prospects of a link-up with the railway line into Nyasaland.

As far as future ports for the Union of South Africa are concerned, the potentialities of Sordwana Bay and Kosi Bay have again received some publicity. Dr. Malan's visit to the former, in August last, has aroused considerable interest in the Union, for the need for an additional harbour on the east coast, with accompanying railway connections, to develop the coal deposits of the Eastern Transvaal has been recognised for some years past. Hitherto, however, the difficulty has been that traffic offering would be in one direction only, i.e. coastwards (export coal), but now that energetic steps are being taken to develop the extensive and productive area irrigated by the Pongola River, there is a probability that the demand for imported goods will increase.

While this proposition finds favour in many circles, there are some authorities who only regard it as a possible long term policy. They stress that, with the prevailing capital shortage, it would be wrong to spend vast sums of money on a new project, which in any case would take years to complete, when the capacity and efficiency of the port of Durban could be improved much quickly of Durban could be improved much more quickly and at less cost.

Suggested De-centralisation of Transport Administration.

Contemporarily with the foregoing there have been trends among port users which may have considerable significance. At the end of October last, the Association of Chambers of Commerce of the Union, at their annual congress, adopted an important resolution to the effect that members were of the opinion that the size of the Union's transport undertaking had reached a stage where there is excessive concentration of management of a wide and often conflicting diversity of interest and claims. They urged therefore that the three services, Air, Railways and Harbours should be split into independent groups, each with a separate staff and financial organisation under the management of a Deputy General Manager, but also under the co-ordinating control of a General Manager of Transport.

The resolution was put to the congress for the Durban Chamber of Commerce by Mr. R. R. Butcher, who drew attention to the fact that abroad it was the exception for harbours and airways to be administered as part of a railway organisation. He said that "Turning first to Britain, we find that the great ports of Liverpool, Birkenhead, Bristol, Glasgow, Swansea and London are all administered by independent port authorities. In the United States we find that there has been a marked trend to adopt some variation and modification of the Port Authority System which is exemplified by the Port of London Authority. Outstanding examples are San Francisco, Houston, Los Angeles, New Orleans, Seattle and the combined port of New York and New Jersey. This trend on the part of American ports to adopt the Port Authority type of organisation for ports is a high tribute to the efficacy of this form of administration.

"The fact then that so many of the greatest and busiest ports in the world are administered in this fashion gives sound ground for enquiring into the special features which render each administration so successful. These may be briefly summarised:—

(1) Port Authorities are autonomous and independent bodies. They are endowed with almost unlimited powers on the one hand and combine the duties of administering, planning and developing the port on the other. It is this combination of wide powers and duties which render these authorities so successful. Where they are separated, as they are in South Africa, there must be a loss of efficiency and interruptions and delays in the process of development.

(2) They are administered by strong and independent boards on which Government nominees are in a minority and the majority represent interested parties who utilise port facilities and who, therefore, have the strongest motives for ensuring the adequacy and efficiency of the harbour, and operation at the lowest cost

(3) The Board is entrusted as its first duty with collecting sufficient revenue to defray interest on capital, any excess of revenue after payment of such interest being applied to port development and modernisation, or in excess of requirements to the reduction of port dues and charges.

(4) Since the Port Authority is independent, the requirements of the port are never subordinate to those of a larger allied organisation as in the case in South Africa.

(5) Port Authorities being on the spot and in daily contact with the problems of port

Railways and Ports of Southern Africa—continued

administration are continuously concerned with planning the evolution of the port.

(6) The staff of such ports being trained all their lives in harbour work tend to become specialists and this in turn produces efficiency. Successful harbour administration requires a staff trained to understand the requirements of, and to co-operation with, shipping and stevedores.

"If we now examine the transport system in South Africa, we find conditions differing widely from those pertaining where harbours and airways are divorced from railways. Since Union, our railway system has undergone vast expansion, involving the building up of thousands of miles of track in the interior, involving acquisition of great quantities of rolling stock and installations and huge increases in staff. . . ."

"The capital value of the railways as shown in the Railway Account figures at £265 million compares with £29 million for harbours and £7 for airways and aerodromes . . . . The very disparity in magnitude between the harbours and the railways makes it inevitable that harbours are relegated to a position of inferiority. The combination of harbours, railways and airways has become too vast and its interests too diffuse to permit it to continue to be run efficiently as one organisation.

"In no respect is this more apparent than in the allocation of capital for expansion, development and modernisation of harbours. Since 1946, despite the fact that harbours have earned an average of approximately £2 million surplus annually after defraying interest charges, only an average of little more than £300,000 annually has been spent on all the harbours in the Union. . . . Thus, during the period 1945 to 1951, the sum of £127,000,000 has been spent on railways, harbours and airways for capital development and betterment works — yet of this enormous sum, harbours have to be content with £3 and a quarter million and airways £8 million. Possibly because attention has been focussed upon the railways shortcomings in recent years, development on harbours has been held up almost completely, and barely sufficient finance has been allocated to them to maintain the harbours in necessary repairs.

"For too long have harbours and airways been regarded as a useful accessor of railways whose chief function has for some years been to provide surplus revenue to permit of the continuation of an uneconomic rating policy on the railways, and administration by successive governments contrary to the terms of Clauses 127 to 133 of the Act of Union.

"Profits of the harbours which should have been devoted to the maintenance and improvement of harbours have been utilised to hide railway deficits and produce a more pleasing overall picture of railway finance. This state of affairs can no longer be tolerated. The time has come when we must more fully appreciate the vital part played in our economy by efficient and adequate harbours. We can no longer allow our harbours to fall behind the ever-changing and mounting demands of modern conditions. Not only does our harbour efficiency exercise an important influence on the whole of our internal cost structure, but it is also going to play a decisive part in fostering the growth of exports of both primary and secondary products in the world markets. . .

"The time has now come for a fuller appreciation of the urgency of port development. Changing conditions make it impossible for any modern port ever to catch up with new developments in trade and industry, and modern specialisation in cargo handling devices and in ship design. This process, however, must be a continuing one and not a spasmodic one. It cannot be retarded or interrupted as it has been since 1946 without disclosing grave deficiencies."

Pointing out that harbour development and expansion is not solely a question of speed of handling cargoes, Mr. Butler deplored the fact that the Harbour Advisory Boards, which were formed to play a major part in the development and administration of the harbours in the Union, had been reduced to the role of passively tendering advice when it is called for. They receive no encouragement to initiate suggestions and have been reduced to an atmosphere of frustrated impotence.

With regard to airways the speaker paid tribute to the high standards of efficiency and reliability which have been attained. He pointed out, however, that airways represent the most specialised of all forms of transport, and that all over the world it is the rule that airways are operated by independent organisations.

Mr. Butcher went on to consider the form which the new transport organisation should take, and visualised the three separate autonomous and independent departments as set out in the resolution of the congress. These would be under the control of a South African Harbour Board, situated in Cape Town or Durban upon which each port would be represented. By the institution of such a control, profits made by all ports would be pooled, the Board deciding upon the allocation of surplus revenue.

Development of Indian Ports

Annual Session of National Harbour Board

A number of recommendations relating to development schemes for Indian ports of all categories were made by the National Harbour Board last December at its third annual session. The meeting advocated a change from the present classification of ports to a threefold classification, namely, major, intermediate and minor. The main reason for the proposal to create an intermediate category, is to focus attention on some of the more important minor ports and help them to develop as useful distributing centres. The Board further recommended that the Government of India should collect information relating to facilities available for the salvage of vessels.

Major Ports.

The Board considered the schemes of major ports for the period of the first five year plan, and noted the recommendations of the Planning Commission that the Government should give financial assistance to Rs. 12 crores to major port authorities for carrying out their development programmes. The Board, however, expressed its strong conviction that the sum of Rs. 12 crores was inadequate because, even with this grant, the size of the schemes was still beyond the financial resources of the port authorities.

Intermediate Ports.

The Board approved a scheme of technical assistance by major ports to those in the proposed intermediate category. Under this plan, the ports of Navlankhi, Bedi, Porbandar, Virawal Bhavanger and Mandvi would be assisted by Kandla Port; the ports of Okha, Broach, Ratnagiri and Karwar by Bombay; Mangalore, Kozhikode and Alleppey by Cochin port; Tuticorin, Nagapatnam and Cuddalore by Madras; and Masulipatnam and Kakinada by Vizagapatam. Each major port would set up a small advisory committee consisting of the Chief Engineer, the Docks Manager and Deputy Conservator. The committee would give technical advice on engineering, traffic and marine problems, scrutinise proposals for port works and assist in the conduct and supervision of surveys.

Minor Ports.

The Board recommended that a sub-committee should scrutinise State Government schemes for the development of minor ports and draw up a list of priorities in the light of the total financial resources available for the purpose. The question of creating a Port Development Fund by levying a special charge on all goods handled by all ports, which was suggested by the Board at its first meeting held in November, 1951, was discussed again. It was explained, on behalf of the Government, that it would not be possible to make a free grant to minor ports but that the Government would be prepared to give loans to minor ports up to a sum not exceeding the proceeds of the proposed special surcharge on goods to be imposed by the major port authorities. To that extent the amount provided for loans to major port authorities would be reduced. These proposals were considered in detail by the Board and it finally recommended that it would be simpler to deduct from allocations to major ports, a certain sum of money which the Government of India would be prepared to lend to minor ports, leaving the question of the levy of a special surcharge to be decided by each port.

The Board appointed a sub-committee to consider details of statistics that should be collected and submitted to Government by all ports, major and minor, and make a report before June 30th, 1953.

American Methods of Port Working

A Review of International Opinion

ORGANISATION OF CARGO-HANDLING OPERATIONS

The fact that the equipment of the American ports differs completely from that of the European ports also means that there are differences in the organisation of cargo-handling operations.

Mr. M. Callet, Director of the port of Havre, has this to say on the subject (La Porte Oceane):

" In America a great use is made of the fork-lift truck of which there are many types, some with thin forks, some with pivoting forks and others with fixed and movable jaws. Most of them are run on petrol; there are few electrically driven. They work on the quays with great efficiency, in the sheds, in the wagons, and frequently in the holds of the vessels. Their rapidity and flexibility is extraordinary. They handle large cases, barrels, timber logs as well as pallet stacked merchandise. The trucks cost 4,500 to 6,000 dollars each. They can be hired from various firms from 3 dollars per hour. There are many other types of tractors for other special purposes. One notes at once that on the quayside the mobile machine reigns supreme and apart from the drivers there are few other workers to be seen; however, there are occasions, although few, when man-handling of goods becomes necessary.

" Palletisation is developed to a high degree and in all the ports of America large stocks of pallets are carried. At Galveston there are 30,000 pallets for an annual traffic of goods, out and in, of 1,500,000 tons. The pallets cost 5 to 6 dollars each and are sometimes owned by the Port Authority, who hires them out to stevedore firms (at Houston the charge is 5 cents per ton of cargo handled). Some stevedores have informed me that the use of pallets is overdone: they find that with a mixed cargo of diverse materials they may be more of a hindrance than an aid."

In the sheds the goods are stacked to greater heights than is the European custom, at times the stacks are 5 pallets high. A favourable feature is the large area available for stowing and the manipulation of the trucks which of course makes it so much the easier to organise the handling. Yet another point is that Customs interference is not so difficult as in Europe, of course there is a large coastal trade.

According to the French Mission: " The composition of the gangs is not rigid and when the contractor seeks to improve an operation by the introduction of mechanical equipment he can by trial reach a solution without the docker insisting upon maintaining the strength of the gangs. One must admit that in France in similar circumstances there are two obstacles: (a) the worker does not want mechanisation if he knows that the numbers of the gang will be reduced; he insists upon maintaining the strength; (b) when it is sought to determine the optimum number of workers for a new machine one must cautiously begin on the short side because later reduction would be difficult if too many were employed on the first trials.

" The fortunate circumstance that the hours of work are easier in the U.S.A. than in France, and that the employer has the liberty to fix the numbers of his gangs are favourable factors towards efficent organisation, besides, the certainty that agreements will be scrupulously kept by both sides results in harmony of operation. One important feature is the great freedom which the employer enjoys regarding mechanical equipment and appliances. He is very seldom harassed by the Unions or workers about the loadings of the cargo trays or the limiting capacities of the slings, as a matter of fact they are used to maximum capacity.

" The loading net is much more used in the U.S.A. than in France and it is not unusual to see pallet loads of 20 sacks weighing 80 kilos each just tipped as a heap into the net. The treatment seems rough but then the manufacturers, well aware of this, provide good packing; indeed the American exporter usually packs his goods in solid and well-wrought materials to guard against careless handling. This perhaps is one of the reasons why the stevedores do not waste much time weighing. They only weigh the damaged cases or packages."

Output Comparisons.

It has already been noted that in the matter of shipping turnround the vessel and its owners are at a disadvantage in the U.S.A. in comparison with European ports, but on the question of cargo-handling the American stevedores are in a happier position for gain.

The French Mission considered at some length the question of the output of the individual American docker and the net cost against that of the French docker. The argument takes the following form:

" The price of handling bulk cargoes,

Loading grain	... ...	45 cents per ton,
Unloading mineral	...	1.15 dollars per ton,
Loading coal	... ...	28 cents per ton.

" Of the installations visited, the most modern for coal loading cost 8,500,000 dollars, so that taking amortisation at 30 years, the annual sum to set aside would be 460,000 dollars. For a traffic of 200,000 tons annually (say 200 vessels of 10,000 tons) this represents 23 cents per ton which must be compared with the 28 cents cost of loading given above. This example shows how essential it is to maintain a high volume of traffic to pay for the machine apart from the high cost of maintenance.

" The revolving gantry crane at Newport-News cost 700,000 dollars. Taking amortisation at 15 years this represents 60,000 dollars annually. Then if the machine works 2,000 hours per year dealing with 150 tons per hour the total cargo discharged will be 300,000 tons, which will represent a charge of 20 cents per ton to pay off the capital used to buy the machine. Compare this with the cost of unloading mineral at 1.15 dollars per ton given above."

Regarding general cargo the French Mission calculated that the cost of a normal gang at the port of New York, including social charges and allowances for equipment, and profit amounted to the sum of 78.44 dollars per hour. This total is comprised of:

Wages	67.5 per cent.
Social Charges	17.7 per cent.
Equipment and Appliances ...	5.5 per cent.
Profit	9.3 per cent.

It was also calculated that the cost per ton for cargo-handling at New York was:

Unloading:

Cases	4.9 dollars.
Sacks of 2 cwt.	2.90 dollars.
Oranges	3.57 dollars.
Vegetables in crates	5.60 dollars.
Sawn timber	3.14 dollars.
Steel reinforcement	5.22 dollars.

Loading:

Copper pigs	2.38 dollars.
Sacks of material	2.61 dollars.
Barrels of oil	2.38 dollars.

It is instructive to compare these figures with the actual prices given to the French Mission direct by stevedores at New York:

Loading:

Cases	2.85 dollars per ton.
Sacks of 2 cwt.	2.51 dollars per ton.
Heavy cases (3 to 6 tons, plus hire of crane) ...	5.20 dollars per ton.

Unloading:

General cargo	3.00 dollars per ton.

At Norfolk and Newport-News, the cost of loading and unloading general cargo was 2.46 dollars per ton.

SUMMARY

The French Mission sums up: " To compute the level of productivity of port operations for uses of comparison between foreign countries, a basis must be defined for measurement, even if it is only approximate. The productivity of cargo-handling can be

American Methods of Port Working—continued

characterised by two factors, the output or time for the job and the nett cost. To take the items singly the amounts would not be correct, for example, high outputs, or yields, could be achieved with a large number of gangs, with powerful and costly machines and yet would not signify a high level of productivity; similarly high cost could result from manual labour very highly paid and correspond however to a satisfactory level of productivity.

" We are of the opinion that productivity can be evaluated from the cost of a job effected on a ton of goods: this cost related to the ton is, in effect, directly a function of output, at the same time output of manual labour and output of the machine. For a comparison to be made between countries where the levels of wages are totally different it will be necessary to evaluate the cost in function of the price of labour. We shall say that the productivity will be so much the more high as the ratio between the cost of cargo-handling of a ton of goods and the hourly wages of the worker will be lower."

This said, let us consider in the first place the normal hourly wages. The " Lloyd Anversois " reviewer comments on these matters by the following argument:

For New York the hourly wage is about 2 dollars, to which must be added 26 per cent. social charges, making it 2.52 dollars or 882 Frs.f. For France the (cat. A) day's work is 1.175 Frs.f., which for an eight-hour day is 147 Frs.f. per hour, to which one must add 65 per cent. for social charges, etc., which gives 242 Frs.f. per hour.

For Antwerp on similar evaluation the normal hourly wage is 49.30 Belgian Frs. or 346 Frs.f.

Therefore the hourly cost of the New York docker is 3.6 times that of the French docker and 2.5 times that of the Belgian docker.

In New York the cost of general cargo has been given at 3 dollars per ton (in French money 1.050 Frs.f.). The costs in France and Antwerp for a similar job are 590 Frs.f. and 316 Frs.f. respectively.

From these values we can compute the co-efficients of productivity:

$$\text{New York} \quad \frac{882}{1050} = 0.84$$

$$\text{France} \quad \frac{242}{590} = 0.40$$

$$\text{Antwerp} \quad \frac{346}{316} = 1.10$$

It is apparent that the French Mission in comparing the output of European ports had not considered the port of Antwerp in their computations, for the above figures show that although the French productivity is only half that of the American, our productivity in the port of Antwerp, by the same argument, is 30 per cent. greater than New York. However, to be prudent, excluding the port of Antwerp, one must admit the superiority of productivity of the American ports, and it behoves us to find a suitable explanation. It must also be borne in mind that the price per ton loading comprises profit, which is not quite the same in different ports and besides the same operation may not be covered by the price.

These figures should be taken as approximate guides only.

Applying the same method of analysis to the port of Rotterdam and evaluating in French monetary terms we get

$$\text{Rotterdam} \quad \frac{161}{519} = 0.31$$

for the co-efficient of productivity which is a remarkably low figure for such an up-to-date port.

Factors Affecting Costs.

Basing the costs of cargo-handling on dollars for a gang of dockers at the port of New York at 1.5 dollars, then the costs of a similar amount of handling in France would be 2.0—2.5 dollars. This difference is due to the amounts of the social charges, which are higher in France and represent 60—65 per cent. of the wages against less than 30 per cent. in the U.S.A. The expenses on equipment, maintenance, fuel, etc., are more or less equal in basic figures.

The output of the dockers and the installations favour the U.S.A.

CONCLUSIONS

In the endeavour to find reasons for the better productivity of American dock labour the French Mission stress the following items besides, as has already been noted at some length, the social atmosphere and the loyalty of the parties to agreements.

(1) The spacious areas at the quays for manœuvring and manipulating goods and machines where work is seldom hindered by bottlenecks and hence there is no stoppage or slowing down of production (but the same may be said of the port of Antwerp where the extent and spaciousness of our quays and sheds are admired by our foreign visitors).

(2) The customary full use of a vessel's derricks and deck machinery wherever possible.

(3) The mobile mechanisation of the shore operations which reduces the quay personnel and speeds up the time required for a job (but such mechanisation is only possible in Europe by completely altering the existing layouts of our ports.)

(4) Palletisation to a large extent which avoids the breaking up of the stacking on the cargo-trays for shore transport.

(5) Installations of special machinery for particular merchandise handling.

Organisation of Commercial Collaboration.

The French Mission again takes up the thread: " Besides the purely technical factors that we have considered it appears it may be necessary to say a word on the advantages that can result for the work of cargo-handling with the assistance of commercial firms:

" (a) To feed sufficient tonnage to allow of the use of special machinery; as a matter of fact, the Americans will only install special machines on the understanding that a sufficiency of traffic will be forthcoming to make the investment of the capital profitable.

" (b) On the diversity of merchandise we know that one of the great difficulties against the acceleration of cargo-handling is the variety of goods which often require long and onerous grouping. The American merchant appears to be less individualistic than the French merchant. If the transport of his goods can be effected cheaper by agreement with one of his competitors he does not hesitate to arrange it. Also it is evident that stevedore firms would be in a better position to reduce charges if the sorting and the grouping of the goods were rendered easier by standardisation of the dimensions and weights of the packages, the reduction of the number of marks, the avoidance of sorting out individually addressed cases from a quantity of the same kind for several consignees."

What is to be Learned from American Practice?

The French Mission concludes its report by examining how much of the American method can be adopted by European countries, in particular France, to better output, and has this to say:

" We have seen that the high wages paid to the workers was certainly one of the essential factors of the high output. The French worker cannot approximate to higher salaries without a corresponding increase of his individual output in tons/hours.

" It is beyond doubt that the system of price for the job practiced in some French ports stimulates the worker and increases his pay-packet without affecting the price of cargo-handling. However, even with this arrangement there are difficulties. It tends to make certain workers impatient and dissatisfied with others in the gang older, or not so robust, marring the harmony of work so necessary to productivity. It also tends to negligence in the quality of work particularly in stowing and stacking.

" Hence one concludes that the traditional ways of working in certain ports where it has been possible to pay actual high level wages at the same time as the tariffs of cargo-handling are diminished, when in effect those ways of working are established on sound bases, the improvement of output should profit the worker with better wages as much as the merchant who pays for the handling without lessening the profit of the stevedore firm."

The Belgian commentator draws attention to the fact that the policy of high wages in Belgium has been satisfactory, and in the matter of collective bargaining there is much to accomplish, but

American Methods of Port Working—continued

insists that it is up to the Unions to exact from their branches more scrupulous respect for signatures given to an agreement on their behalf. This implies a greater degree of discipline and less of politics. On the question of the hours of labour the Unions should review their attitude and permit more flexibility subject to adequate and reasonable overtime pay. Regarding this the fear of abuse has developed into a regrettable obsession. Another matter of equal importance is the uncompromising attitude shown in respect of the composition of gangs.

Epitome and Comment.

[Already we have commented upon the necessity of giving heed to opinions which are not our own, suggesting that due allowances must be made for national temperament and points of view. Where there are wide differences of opinion, then that which is factual must be separated from the personal. A very celebrated American essayist once wrote " I like facts and dislike lubricity, I also like people with perception." It was fitting that this sentence should occur in the preamble of an essay on " Prudence," for that is a quality which we must respect in the present argument. It is obvious that our Continental friends are deeply impressed by American methods and the moral values of the workers in all stages of the port industry; and rather surprisingly, and perhaps unfairly, indict their own workers. However, since we are concerned with facts let us examine some features of the actual American situation as given recently in official reports and reputable commercial journals (American).

Briefly, the following items are generally agreed by Americans and foreign visitors alike to be more or less common practice of American ports.

Equipment. There are few dock side cranes.

The ship's gear is almost exclusively used with, at times, the aid of " burtoning " masts for the quayside handling of cargo.

Large stocks of hirable pallets are available and are freely used.

Loading nets, slings and cargo-trays are used to full capacity at every available opportunity.

Quayside Handling. Fork lift trucks of many specialised patterns are in easy supply and can be hired readily.

There are no restrictions upon loads excepting those required for safety.

No company organisation or authority has a monopoly of ownership of the piers, wharves or quaysides of the port.

General merchandise is seldom loaded into lighters, etc.

Full use is made of the floor space of sheds by high stacking, in other words, a full shed is one where the goods occupy the volume of space between floor and roof.

Men and Machines in Action. The team work of the gangs is good, each man does his job apparently leisurely, nevertheless efficiently.

The machines are the elements which are worked full out.

The employer fixes the net or cargo-tray loads without restriction by the gangs: he is the technical authority.

The introduction of new machines, energy saving or labour saving, does not arouse opposition from the dockers.

Bulk cargoes on regular services are dealt with by special machines.

Little time is wasted by the gangs for weighing and checking of goods.

Production of docker in man/tons is high.

Pay per man hour in dollars is also high.

Packaging is more sturdily done by the manufacturers.

It is upon these factors of port operation that the various conclusions of the Continental visitors to America have been built up.

Conceding the favourable nature of the cargo-handling methods and operations, it should follow that a vessel in an American port must have a quicker turn-round than in a European port; but that is the one thing that just does not happen. How then does it come about that these Missions of experts are almost unanimous in extolling the moral behaviour and will to work of the American docker, pointing out the infrequency of strikes? Further, they draw parallels with the behaviour of their own nationals, usually to the latter's disadvantage. Surely there is some gap here in the data that they have collected, some factor of importance is missing. Maybe recent happenings on the American waterfronts will supply the answer: already we have referred to one frivolous strike.

Now the main function of a seaport is the facility it offers as a quiet calling station for the loading or unloading of a vessel's cargo; and the productive value of the vessel, which after all is only a vehicle of transport, ceases as soon as she enters the breakwater heads when she then becomes an expense liability for as long as she remains in the port. Therefore the production rate, or intensity, of dockers at work means little to a shipowner unless it reduces the time of dalliance of a vessel in the port. Obviously then, on turn-round, the American methods and port facilities combined are behind those offered by Europe.

According to the " New York Times " the Civic Authorities have been disturbed for some time about the waterfront situation and its influence in causing a falling-off of ocean-going trade. The competing port of Baltimore is now clearing 13 million tons and continues to increase against a fluctuating New York total of 22 million tons. Recent strikes at New York and the quicker turn-round at racket free ports are said to have influenced this transference. High figures are quoted for the racketeers' share of New York trade on the waterfront, indeed it is said that £100 million per year finds its way into the coffers of racketeers. Dockers earning about 25 dollars per day are said to hand back 5 to 10 dollars to their " dock " bosses.

The situation has become so serious that a well-known firm of Consulting Engineers of New York has been directed to investigate and report on the physical condition of the waterfront and its bearing on the social and industrial activities. They are to study the pier facilities, the extent of the traffic blocks at the pier heads, the extent to which congestion is caused by rackets and loading irregularities. To further fill the rather gloomy behind the scenes picture they are also to investigate the trade loss to the port and the hold-up of the port's rehabilitation programme caused by port racketeering influence.

The evidence given before the New York State Crime Commission as reported in the " New York Times," shows that stevedoring firms were forced to buy " Goodwill " in the docks by systematic bribery to all sorts of officials: in fact, it was alleged that large sums were paid to the President and his assistants of one of the dockers' unions besides sundry " hoodlum dock bosses." Indeed it was asserted that it was the established practice to regularly send goodwill presents to union officials. One astounding item was the alleged payments to " hiring bosses," people who apparently maintain industrial peace on the waterfront by preventing strikes!

One cannot help but think that if a hiring boss can prevent a strike he can also foment one. It is indeed a sorry picture and blots out with an icy chill all those kindly reflections of the European Missions on their American journey.

To sum up the various data adumbrated above,

(1) The diversity of traditional handling methods even in ports of the same country make close comparison of individual effort difficult to assess, and when comparison is made between foreign countries the difficulties become almost insurmountable.

(2) The factors affecting production are usually complex: the worker and his attitude: the employer's ability to organise and to lead: extent of clear quay and shed space: supply and nature of shore transport: methods of avoiding congestion, and handling of goods in their order of destination: prevalent weather in the port: wet dock or river wharfage, etc., tidal range.

(3) The important factors would appear to be:

The time of turn-round of a vessel, the sum total of the port charges against the vessel, and the total cost of the cargo handling in the complete loading, or unloading, whilst the vessel is in the port. If costs were computed on this basis a much clearer idea of the efficiency of the port could be arrived at.

For example, let us consider two vessels of equal tonnage and similar cargo in two different ports of the sterling area:

let, W. = deadweight of cargo in tons.
T. = turn-round in hours.
p. = total amount of port charges in shillings.
h. = total costs of cargo handling in shillings.
C. = p+h total cost of sojourn in port.
N. = a simple number, basis of comparison.

American Methods of Port Working—continued

then the cost per ton of cargo, loaded or unloaded, in the port is

$$C/W$$

and the average handling of the cargo in the port taken over the full time of call is

$$W/T \text{ tons per hour.}$$

From this we can arrive at the dimensionless number

$$N = (C/W) / (W/T)$$
$$= C\,T / W^2$$

Let us further assume that two vessels are each of 1,000 tons and that vessel A is in her port for 80 hours at a total cost of C=£150, and that the vessel B is in her port for 100 hours at a total cost of £100,

then for A,

$$N = \frac{150 \times 20 \times 80}{1000} = 0.24$$

and for vessel B,

$$N = \frac{100 \times 20 \times 100}{1000} = 0.20$$

From which we deduce that the port of the vessel B gives the more satisfactory return although it is not the quickest turn-round. (It is assumed that the saving of £50 is a good return for the 20 hours extra time in port.) If on the other hand the port charges C for vessel A had only been £125 then the coefficient of comparison N would be 0.20 in both cases, and therefore the port A of the quickest turn-round would be the more preferable.

The point is that the cost of cargo handling is a more complex matter than the production of the docker only.

(4) The docker is no simpleton, in fact, he is usually a tough worker of wide experience, and the last thing to do is to spoon feed him or treat him in a schoolmasterish manner. The labour troubles to-day are not confined to port workers and little else can be effectively done until the ferment settles.] R. R. M.

Symposium on Timber Handling

Report on London Meetings

A timber symposium, arranged by the International Cargo Handling Co-ordination Association, was presented on February 19th and 20th last, and about 100 delegates, including a number of overseas members, attended the proceedings. Rear-Admiral A. L. P. Mark-Wardlaw, president of the Association's Executive Committee, presided over the first day's programme, which took place on board the "Wellington," headquarters ship of the Honourable Company of Master Mariners, whilst on the following day delegates visited the installations of the Phoenix Timber Company, Ltd., at Frog Island on the River Thames.

The first paper was presented by Mr. A. C. Priddle, who taking as his subject "World Timber Trade," gave a wide background survey of the position of the trade and the difficulties it experiences at the present time. This was followed by a paper by a visitor from the Netherlands, Mr. L. A. van Nifterik, on "Timber Storage," and a paper by Mr. G. B. Crow on "Timber Storage Sheds," both of which provoked interesting discussions from the body of the meeting.

Commander A. C. Hardy, chief co-ordinator of the I.C.H.C.A., next read a paper entitled "Timber Ships" and gave details of a number of unusual and interesting types, including an original Dutch design of 1932, which featured gantry cranes and box-shaped holds. Although a ship to this completed design did not materialise, an order for three of these vessels was placed by the U.S.S.R. with the Netherlands Shipbuilding and Docks Company in the early 1930's and the first ran her trials in 1936. The gantry crane facilities in the Dutch design were replaced in these ships by a fairly conventional goalpost mast, derrick and winch arrangement. Commander Hardy also gave examples of Japanese and Canadian designs.

In the discussion which followed, speakers said that the type of vessel described in Commander Hardy's paper would have only a limited use, as it could only be employed on specific routes where the tidal range at the quayside was too small to affect the use of the comparatively short jib of the cranes. Another speaker suggested that ex-L.C.T.s might be used, as he thought that these vessels' difficulties of loading by derricks or cranes could be overcome, the cargo being loaded straight on to vehicles in the hold.

The first paper of the afternoon session was entitled "Timber Handling" and was read by Mr. P. M. Combes, who compared the different methods adopted in Great Britain and the U.S.A. He was followed by Mr. H. Allen, assistant to the general manager, Port of London Authority, who gave details of an experiment in mechanisation which had taken place this year, and expressed appreciation of the co-operative attitude adopted by organised labour in assisting with the experiment. He pointed out that extra operations, such as sorting the different sizes of timber being discharged, were the negation of mechanisation and so were hindrances to the successful application of mechanical handling devices in the timber trade. Continuing, Mr. Allen said that the P.L.A. hoped to build its softwood trade up to two-thirds of its pre-war level, and pointed out that 80 to 90 per cent. of the timber arriving in the Surrey Docks was discharged overside.

The realistic attitude of the trade unions towards mechanisation in cargo handling methods was confirmed by Mr. A. Gourovitch, who presented an illustrated paper on "Timber Handling at Rainham." Describing the post-war developments of his Company, he said that the timber installation at Frog Island, Rainham, consists of two Mulberry floating pontoon units connected by a floating bridge to storage sheds and yards. The firm now have a floating platform 412-ft. long and 60-ft. wide, connected to the mainland by a floating bridge 180-ft. long. The berth has been dredged to 21-ft. L.W.O.S.T. The speaker referred at some length to the handling equipment and operations employed at the quay, and concluded by saying that they had learnt that certain ships were less desirable from their point of view than others. They had a list of ships which they would rather not have on equal terms. Some of them were old, with small and awkward hatches, others had difficult 'tween decks. The list also included some of the modern types of ships with holds forward and engine aft. That type of vessel forced their cranes to work in too concentrated a space whereas the old fashioned bridge in the middle gives them that additional spread in the positioning of the cranes which they found essential.

On the following day the delegates visited Frog Island and had the opportunity of actually witnessing the discharge of the Swedish vessel "Eriksborg" at this Mulberry pier. The visitors were also shown the facilities provided at the pier, and demonstrations were given of the Timber Wolf Straddle Carrier and the Rapier 12/24 Fork-Lift Truck.

Oil Refinery for Port of Geelong

Australian Expansion Programme

Now nearing the half-way construction stage at Geelong, near Melbourne, is a modern oil refinery which, on completion in mid-1954, will be the largest in Australia. It will have an annual output of over one million tons a year of various petroleum products. Under present plans, crude oil for the refinery will come from the Seria oilfield of British Borneo which is virtually a 100 per cent. sterling source of supply.

The new refinery, which is being built by Shell at a cost of £A9 million, is situated on a 250 acre site, five miles north of Geelong. Thirty-four storage tanks with a capacity of over 200,000 tons are under construction, while the Geelong Harbour Trust plans to dredge the port approaches to a depth of 32-ft. and to construct a special jetty to accommodate ocean-going tankers.

Work has also started on a £A500,000 8-in. pipeline which will be used to carry oil products to Melbourne, 36 miles away. Due for completion towards the end of this year, it will be Australia's longest oil pipeline. The total volume of the line will be 418,000 gallons and the estimated maximum throughput 225,000,000 gallons a year, but this can be raised to 600 million by the provision of an auxiliary pumping station. This pipeline is the first major project of its kind in Australia, and it will introduce for the first time the modern technique of handling two dissimilar refined oils in direct contact with each other. Its delivery capacity of 28,500 gallons of petrol an hour is over double the present consumption rate in Melbourne. The Geelong project is one item in an £A86 million expansion programme now being carried out by the oil industry in Australia.

Manufacturer's Announcements

Arpic "Tornafix" Air Compressor

Arpic Engineering Limited of Queenslie Estate, Glasgow have introduced the Stationary Model 315 "Tornafix" Air Compressor, and the first of this type, built at the Glasgow Works, is now being used on quarry work at Inverness.

The unit is a three-bank, two-stage, air-cooled compressor consisting of four low pressure cylinders set in V-formation and delivering air through a sectional intercooler to a central vertical bank of two high pressure cylinders and from there to the air receiver; the actual air output is 315 c.f.m. at 100 p.s.i.

The lubrication of the compressor is effected by a pump driven directly from the diesel engine, ensuring that, when the diesel is started up, a constant supply of high pressure oil is instantly available for effective lubrication. Clutch transmission is operated by oil pressure from a simple clutch control button.

The unit is powered by an 11.3 litre A.E.C. water-cooled industrial engine, which is a development of the commercial vehicle engine and rates 118 b.h.p. at 1,400 r.p.m. Fuel injection is through the medium of a Simms fuel pump.

The Arpic "Fuelmiser" is fitted, which operates in conjunction with the variable speed type of centrifugal governor and is designed to automatically adjust the power demand in accordance with variations in air demand on the compressor air receiver.

General Purpose Power Loaders

Two new machines built to accomplish many every-day lifting tasks are now ready for marketing to industrial users at home and overseas through Lister Auto-Truck Sales (R. A. Lister and Co. Ltd.) of Dursley, Gloucestershire. They are the Lister 16-ft. and 24-ft. General Purpose Power Loaders, the former having a maximum delivery height of 12-ft. and the latter a maximum delivery height of 18-ft.

Designed to lift cases, bales, sacks, crated packages and certain types of unpacked merchandise, the loaders are of interest to port

authorities, railways, central markets, and public and private concerns utilising such handling equipment.

Major features of the design are lightness in construction combined with strength and manœuvrability. The power loaders are so balanced that one man can move and position the machine for correct loading and delivery, the approximate weight of the 16-ft. type being 7 cwts. and of the 24-ft. type 10 cwts. The main frame is of rolled steel with welded box-type steel cross bars to give rigidity, whilst the moving platform consists of wooden slats bolted to heavy welded steel-linked chain. These slats carry the load instead of pushing it up in the manner of the "fixed bed" type of elevator. To the wooden slats are fixed removable angle irons, which are used for loading cases, bales or sacks, whilst an adjustable attachment is fitted when dealing with unpacked material.

Two strong wooden side boards are fixed to each side of the power loaders, but these can be removed with ease, an advantage which is apparent when handling bagged produce. With the side boards removed, a wider platform is available, and there can be no fear of sacks being damaged by catching on any projections or by rubbing.

One of the unique features of the power loaders is the patented device for raising and lowering the platform. This is achieved by a mechanically-operated telescopic tube which adjusts the height with little physical effort. The 24-ft. type is fitted with a double action telescopic tube to give the necessary extra litt. For stability during loading, there is an adjustable telescopic stand.

Drive for the power loaders is provided by a 2½ h.p. air-cooled petrol engine (electrical motor drive can be fitted if desired). The moving platform is started and stopped by means of an ingenious combination of belt guide jockey pulley and clutch. The main drive between the jockey pulley and the platform is by two V-belts, and platform speed is 100-ft. per minute (approx.). Pnuematic tyred wheels are fitted.

New Tug for Aden Port Trust

The motor tug "Maamal," ordered from the Fairmile Construction Co. Ltd., Cobham, by the Aden Port Trust, has recently completed her trials. She has been designed by the Fairmile organisation for general harbour purposes, towing barges and hoppers. The craft has a straight stem, duck type stern, a flush deck and tumble home bulwarks. Bilge keels and fore and aft peak ballast tanks are fitted.

A feature of the vessel is that a Kort nozzle is fitted round the propeller, the stern of the tug having been designed to obtain the best results with this device. Some 200 craft have now been fitted with Kort nozzles, and it is accepted that the static pull for a given power is appreciably increased by its use.

The Blackstone engine installed is stated to be an improvement on the type it supersedes, having a higher power output, and a reduced fuel consumption. The engine is equipped with a hydraulic damper at the forward end, as well as a flexible pin type coupling to isolate it from the reverse gear, thereby reducing criticals to a minimum. The camshaft can now be removed as an assembly, and the connecting rods and pistons can be withdrawn through the crankcase. Fresh water cooling is employed; the heat exchangers being of Serk pattern.

Fairmile are also building one 150-ton aluminium alloy and five steel dumb barges for Aden. These will be used in the construction of the oil port for the new Anglo-Iranian oil refinery, and both types of barges are being shipped in floatable halves.

TENDERS.

DREDGING AT DUNDALK HARBOUR.

NOTICE TO DREDGING CONTRACTORS.

Tenders are invited by the Dundalk Harbour Commissioners from firms of Dredging Contractors for the dredging of approximately 119,000 cubic yards from the Inner Harbour and 89,000 cubic yards from its river and bay Channel Approaches, all within the limits of the Harbour of Dundalk. The aforementioned quantities are based on measurement "in situ" of solid material before dredging. Copies of Drawings, Specification, Bill of Quantities, and other Contract Documents, prepared by Messrs. Charles G. McNamara, M.E., M.I.C.E., M.I.C.E.I., and Partners, Consulting Civil Engineers, 27, Merrion Square, Dublin, may be obtained from them or from the undersigned on payment of a deposit of £10 10s. 0d. which will be refunded on receipt of a bona-fide tender.

Sealed Tenders, on the form provided, accompanied by Bill of Quantities, priced and extended in ink, together with other issued Documents and Drawings, addressed to the undersigned and endorsed "Tender for Dredging", are to be delivered to the Harbour Office, Dundalk, not later than 12 noon on the 6th day of April 1953. The lowest or any tender will not necessarily be accepted; and the acceptance of any tender will be subject to the sanction of the Minister for Industry and Commerce.

Harbour Office,
Dundalk,
26th February, 1953.

MARY MALLON,
Secretary,
Dundalk Harbour Commissioners.

PUBLIC APPOINTMENTS.

ASSISTANT CIVIL ENGINEER required by London Consulting Engineer for Resident Engineer's staff on large harbour contract in Middle East.

Applicants should possess a degree in civil engineering or be exempt from parts A and B of the Associate Membership Examination of the Institution of Civil Engineers.

Site experience essential—preferably on dock and harbour work in a tropical climate.

Liberal salary and leave; also free messing, laundry and furnished air-conditioned living accommodation.

Apply by letter giving full particulars of age, qualifications and experience to Box No. 6565, c/o Charles Barker & Sons, Ltd., 31, Budge Row, London, E.C.4.

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